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STREET PAVING PROBLEMS

We hope that our readers who find anything in the series of articles on Street and Road Pavements with which they are not in accord, will give their point of view and reasons for differing, if they do, or will ask any questions necessary if the articles are not clear.

There are many chances for difference of opinion, especially in the classes of pavements under consideration in the current numbers and one purpose of these articles is to induce discussion in a scientific spirit of these points where differences of opinion occur, so that the facts can be agreed upon as nearly as possible. Then the differences of opinion will be reduced to a minimum, perhaps even to the point of eliminating all but those based on commercial exigencies.

The articles do not present a single point of view but quotations are made from various authors, engineers, chemists and constructors, which give as nearly the facts in the various cases as possible, and also present some of the differences in opinion based on these facts. To a certain extent they reflect the editor's conclusions, drawn from his study and experience, but no one could agree with all that is given in the articles at one and the same time. But even if they were such a statement of his opinions, he would welcome discussion. If you have anything to say, write it down at once and send it in.

ENGINEERS AND THE WAR

How many of our readers have put their names down on the numerous lists of engineers who may be called upon in case of need for war service?

Universities, societies, national and local, committees on preparation for the war, are all distributing lists of questions the answers to which are intended to show the qualifications of every engineer, the kind of work in which he thinks he would be most efficient and the apparatus or material which he has on hand or can secure which would be usable in case of need.

It seems probable that but little of this material or but few of the men will be required, but the most efficient and prompt service can be secured at the least cost of disarrangement of present industries, as well as of time, money and loss of opportunity, if all the resources of the country are catalogued and filed as the system, of which these questions and answers form a part, contemplates.

Much of the service will be rendered in this country and much will be of such nature that the limits of military age and physical ability do not apply to it, so that you should fill the blanks with due statement of such limitations and disabilities, so that you can be used at home, releasing those of military strength for service abroad when they are needed. Put your names and qualifications in the catalog, either thru your college or society, or directly thru the Engineer Reserve Corps of the Army at the U. S. Army Headquarters of the Division for the state in which you live.

CHANGES IN STANDARD SPECIFICATIONS

The chairman of the Committee on Standard Specifications of the American Society of Municipal Improvements, George W. Tillson, Boro Hall, Brooklyn, N. Y., expects all changes in specifications proposed by the sub-committees to be in his hands on or before September 15, that the reports of the committees may be printed with the advance papers for the convention to be held in New Orleans, November 12-16. Those desiring any such changes must therefore present them to the chairman of the proper subcommittee in ample time for discussion by the subcommittee and incorporation in its report, at least as early as September 1. Copy of the proposed changes should also be sent to Mr. Tillson. It is understood that no proposals for change of specifications will be considered by the committee at the convention or by the convention itself which has not been first presented as above provided.

Mr. Tillson is also chairman of a special committee to consider changes in the constitution of the society and members can make to him any suggestions regarding changes which they may deem advisable. The report of the committee on revision of constitution will also be printed with the advance papers and any communications regarding it should reach Mr. Tillson by September 1.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

EDITED BY CHARLES CARROLL BROWN, M. AM. SOC. C. E.

THE CONSTRUCTION OF BITUMINOUS PAVEMENTS

By the Editor and Others Quoted.

In the preceding article the plant section of the construction of asphalt pavements was considered. For other bituminous pavements requiring mixing of materials the general operations at the plant should be carried on under the same principles, tho details vary greatly for the different bituminous pavements, ranging from bitulithic to bituminous macadam, mixing method, and only such differences will be mentioned here and later. The operations on the street are also different, mainly in detail, and that end of the work of construction is the principal topic of this article.

IT is assumed that the foundation of the street is properly laid and that only the placing of the bituminous wearing surface is to be considered in this article, the material therefor being supplied by the plant as described in the preceding article.

Laying Asphalt Pavement.

The asphalt wearing surface is an intimate mixture of sand and asphalt with the proper proportion of stone or cement dust to temper the softness of the mixture and aid in filling the voids. In theory every particle of mineral matter, large or small, must be covered entirely with a film of asphalt, which in this finely drawn out condition has an enormous surface tension, tending to hold the particles of mineral matter close together when they are in proper proportions of larger and smaller sizes from sand to the finest dust to make the voids in the mixture of mineral matter a minimum, and the mixture has been thoroly rolled into place so that the particles are forced into as close relations with each other as possible. The result of this process, when 9.5 to 13.5 per cent of bitumen by weight is used, is a dense pavement, waterproof and capable of withstanding heavy wear. The percentage of bitumen by volume is greater than the above percentage by weight, since bitumen has a lower specific gravity than the mineral matter.

The unstable sand, mixed with an asphalt cement, which could not carry traffic if used alone, produces a compound, if properly proportioned, tempered, and mixed, which forms a stable and durable paving mixture, for the reasons above suggested and fully elaborated by Clifford Richardson and others. The necessity of close adherence to the proportions fixed by the chemist and of most thoro mixing and rolling are thereby demonstrated, as well as the necessity of treating the mixture as to heat, standing in truck or on street, and handling, so that there will be no separation of the mineral matter from the bitumen.

Experience has shown that the wearing surface mixture does not surely adhere to the concrete or other foundation even when it is left rough in an attempt to form a bonding surface, and that pavements so laid roll and shove. The standard specifications therefore require a binder course which is a mixture of 4 to 7 per cent of bitumen, 15 to 35 per cent of material passing a 10-mesh screen and 20 to 50 per cent passing a ½-inch screen, according to character of material and traffic conditions. This mixture does not have the voids in the larger stone completely filled, and is quite porous and permits a close union of the wearing coat with the upper surface of the binder. In this way, if neither binder nor wearing surface is too soft and neither binder course nor the surface of the concrete is lubricated or injured by the absorption of water, there will be no shoves or rolls in the completed pavement. While the mixture for the binder course need not be as carefully designed or mixed as the wearing surface, it is a very important part of the pavement and must have its full share of careful attention. All inequalities in the foundation must be taken up by the binder course and the top surface when finally rolled must be parallel with the finished surface of the wearing coat.

The care with which the binder course must be laid is indicated by the standard specifications that temperature must be carefully regulated; that spots showing an excess of asphaltic cement after rolling (due, probably, to imperfect mixing or to separation of mixture in transporting and handling) must be cut out and replaced with better mixed material; that any binder showing a lack of bond or whose bond is broken after rolling or is otherwise defective shall be cut out and replaced with good material. Each spot of defective binder which is covered by the wearing surface without correction is a source of danger from rolling or shoving or crushing under load or disintegration.

The binder course must be clean when the top is laid on it, swept if necessary, and the top should be laid before the asphaltic cement of the binder has become cold. The best results are obtained when the wearing surface is laid promptly after the completion of the rolling of the binder course. Failures occur not seldom from laying top on wet binder.

The limit of variation in irregularities in the concrete or other foundation which can be taken up by variations in the thickness of the binder is rather large, 40 per cent of the average thickness. Thus, if the average thickness is 2 inches, the thickness of the binder course may vary from 1.2 to 2.8 inches.

The thickness of the binder and surface coats varies according to local conditions of traffic, temperature, etc., according to the limitations of cost, and according to the preferences of the designing engineer. The variations found in practice are shown in the article in this series on the design of bituminous pavements.

The asphalt surface is so smooth that contractors are sometimes careless in making it uniform and even. This is a serious defect in construction even when the longitudinal grade of the street is heavy because the depressions in such an uneven surface will hold water and no pavement will withstand the action of water and of frost on water for a long period of time. One reason for inequalities in the rolled surface can be removed by a little care. When the asphalt mixture is

LAYING BERMUDEZ ASPHALT CONCRETE ON RIVERSIDE DRIVE, NEW YORK, ON CONCRETE FOUNDATION. TWO LAYERS OF 1½ INCHES EACH TO INSURE PERFECT COMPACTION.

dumped from the truck in which it is brought to the street it consolidates somewhat under the weight of the mass, and the material shoveled and raked out to form the layer does not have this initial consolidation so that it will settle down under the roller more than the undisturbed area at the place of dumping. The inequalities in the surface which result can not be rolled out. The remedy is to dump the truckload of mixture where it must all be shoveled into its proper place, thus giving the roller practically the same work to do on every square foot of the surface. The small amount of extra labor required for shoveling the whole load instead of only what can not be raked out is much more than compensated for by the less difficulty in rolling and the greater uniformity of surface. On level streets, where drainage must be secured by change in depth of gutter, uniformity of surface is absolutely essential, especially at the summits of the gutter grades where the curb has the least height and the crown of the street is the least. Here the smoothness of the surface is the only dependence for adequate drainage. Expert raking of the asphalt to surface, prompt first rolling so that any deficiencies in thickness due to errors in raking can be corrected before the mixture becomes too cold to rake up to receive the new material, are essentials of accurate work in producing uniform surface. A straight-edge 12 or 14 feet long is a material aid in securing the necessary uniformity of surface, particularly when the rakers are not highly expert or are not dependable workmen.

Cold mixtures are producers of uneven surfaces. For short hauls horse-drawn wagons are most economical, but the loads should be as large as possible, to retain the heat on leaving the plant as nearly as possible. For long hauls the loads should be as large as possible for the same reason and the motor truck will be found desirable to carry the large loads and to reduce the time of haul from plant to street. The trucks should have steel inner linings, asbestos interlinings and wood outer linings and should be equipped with light steel and asbestos covers, all for the purpose of keeping the heat in the load until it is ready to spread on the street. Light oiling with the residuum oil used for fluxing will prevent the load sticking to the steel lining, but the least possible quantity should be used.

The loading of trucks is most important from the point of view of economy. A truck should be built to carry a certain load, says 5 tons, over rough ground such as may often be found near the plant, especially if it is a railroad or semi-portable plant located off the paved roads. It must often travel over roads also at or in the vicinity of the street to be improved. In case the yard at the plant and the approaching streets are well paved and the streets on the way to the job are also in good condition the truck may be loaded safely to 7½ tons, with a considerable increase in economy. But it does not pay to overload a truck. Breakdowns, causing delays or transfers of loads, trucks out of commission, cost of repairs, all mount up fast and soon wipe out any economy shown by figures based on safe operation of trucks as to loads and speed. Good judgment in suiting loads to roads to be traveled is worth much money.

It is the opinion of some engineers that failures of asphalt pavements are due more frequently to binder troubles than other causes. They may be any one or more of the following: Laying binder on green or very wet concrete or on a dirty, unswept concrete; use of insufficient bitumen or burned bitumen; too large maximum size stone in aggregate; lamination in stones; laying mixture when too cold; rolling too much when cold; allowing traffic on binder before top is laid; laying top on dirty, defective or wet binder. To these may be added as causes for failures of asphalt pavements sub-grade difficulties, such as settlements from careless backfilling or lack of time allowance for settling of fills and poor drainage; foundation failures due to defective concrete materials; too little cement or mortar or imperfect mixing of concrete; and failures of the surface coat due to failure to suit the amount of filler and the hardness of the bitumen to the kind of traffic and the climate, or to the action of frost on water getting into the joints along curbs, manholes, and street railway tracks.

The following by Lester Kirschbraun adds weight to what precedes:

"One of the most striking advantages of a bituminous surface is its smoothness. It is by no means a simple matter to produce a smooth surface in a bituminous pavement, and it requires constant and faithful attention to details of workmanship in order to accomplish this desirable result. In order to produce a smooth surface on mechanically mixed work it is desirable that the course upon which the surface is laid be as even as possible so that a uniform thickness of surface may be applied. It is desirable that the mixture be brought to the work at a temperature at which it may be easily manipulated. The paving composition should be broken up thoroly to free lumps of partially compacted mixture. The raking should be of such character that the mixture is broken up and combed out to a uniform degree of looseness, so that when the rollers are run upon the surface an even degree of compression will result. It is very frequently the practice for the mixture which arrives on the work to be dumped too close to the spot on which it is to be laid, and for the rakers to walk upon the mixture. Any such detail of workmanship which results in a raked mixture of uneven density will inevitably result in an uneven surface. An even thickness of uniform density of loose material is a prime requisite for a smooth surface.

"The compression of the raked mixture by rolling is the

STONE-FILLED ASPHALT PAVEMENT ON MANSFIELD STREET, MONTREAL, QUEBEC.

next operation. The roller should be of the maximum weight per inch of tread which is permissible without imparting too much movement to the raked material. The size of the roller and the stage at which it is applied is, to a certain extent, dependent upon the type of mixture. A mixture of large aggregate and of great stability is best rolled with the heaviest possible roller applied just as soon as the mixture is spread. Mixtures of this kind are too dense to squeeze out under a light roller. Sheet asphalt mixtures, on the other hand, may be rolled advantageously with lighter rollers, applied usually after the mixture has partially cooled and obtained sufficient stability to avoid excessive movement or picking up on the rollers. The rolling is most advantageously done by working from the gutters toward the crown of the street, and the pavement should be rolled cross-wise, diagonally, with various modifications thereof as permitted by the width of the pavement and the conditions under which the work is handled. Rolling should be carried on slowly, at an even speed, without jar or impact, and with particular attention to smoothness of operation in reversing the roller. The length of time during which rolling will be effectively continued is a variable with the temperature and condition of mixture, but it is always desirable to continue just as long as the roller makes any impression on the surface.

"In connection with sheet asphalt pavements, too little attention is paid to rolling of the binder course. This course is the element which provides the stability for the sheet asphalt construction, and its thoro rolling and compaction is essential not only to a smooth surface of the finished pavement, but to the maintenance of a smooth surface under traffic."

Laying Bitulithic Pavement.

Bitulithic pavement being an asphaltic concrete, composed of broken stone, sand and asphaltic cement, laid in one layer, the operations of the plant differ from those described in the preceding article in some details. It is not necessary to change mixers or mixtures for two layers. The stone and sand being separated into several sizes, usually three, and mixed in definite proportions by weight, they are elevated to a rotary dryer like that in an asphalt plant and the hot materials from the dryer are elevated to a rotary screen with mininum opening of 0.1 inch and maximum of 1½ inches. A sample specification of the intermediate sizes is that of Portland, Ore., as follows:

Aggregate passing 1½-in. screen and retained on ½-in., 36 to 50 per cent;

Passing ½-in. and retained on ¼-in., 12 to 20 per cent;

Passing ¼-in. and retained on 10-mesh, 8 to 12 per cent.

To this is added, aggregate passing 10-mesh screen and retained on 200-mesh, 24 to 32 per cent;

Passing 200-mesh screen, 4 to 7 per cent.

Bitulithic cement, 7½ to 9½ per cent.

It is also specified that from 50 to 70 per cent of the aggregate passing a 10-mesh screen shall pass a 40-mesh screen, and from 20 to 35 per cent of the sand shall pass an 80-mesh screen.

These sizes of stone pass from the screen into separate bins and are drawn in the proportions fixed between the above limits into a box on a scale with multiple arms so that the proportions are held exactly, any necessary fine material not obtained from the stone being added.

The proportions stated are varied in different localities according to conditions of temperature, climate, kind of stone and sand and kind and hardness of bitumen. Usually a softer bitumen can be used than with sand mixtures.

The definite weights of the various sizes of stone are mixed in a mechanical mixer with the bitulithic cement at 250 to 300 deg. F. temperature and dumped into a truck for carriage to the street, where the single course is placed, shoveled, raked and rolled in a manner similar to that described for asphalt pavement, to produce a layer usually 2 inches thick, but varied according to traffic, solidity of foundation, etc.

A coating of ¼ gallon of bitulithic cement per square yard is placed over the surface and a thin layer of 25 pounds of hot stone chips per square yard, not exceeding ¼-in. size, is then spread and rolled thoroly into the wearing surface to make a solid, dense bituminous cement.

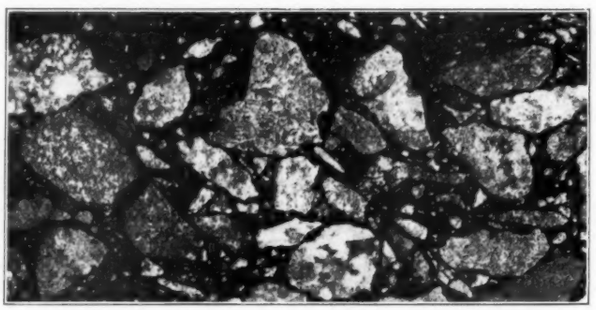
Bitulithic and Warrenite pavements are laid on cement concrete, on bituminous concrete, on gravel bituminous, on broken stone or gravel bases, on old macadam or gravel if well compacted and on solid sub-grade.

Other asphaltic concretes differ from bitulithic in the proportions of the various sizes of stone used and in methods of mixing and laying follow approximately the same program.

Other Asphalt Concretes.

Amiesite is an asphaltic concrete which is laid cold in two courses on cement concrete or other sound foundation. The mixture is made at a central plant, the asphalt cement being haeted for this purpose, and shipped in cars to the place for use. To heat the mass in the cars so that it can be shoveled out steam is used, forced into holes dug in the mass, so that the heat of the escaping steam reaches the whole mass. A 2½-inch course of the binder is laid and thoroly compacted and is followed by ½ inch of the wearing surface, also thoroly rolled.

The so-called Topeka mixture has been modified until it has become a fairly satisfactory asphaltic concrete. Some of the proportions of various sizes of stone used in various varieties of asphaltic concrete are shown in the accompanying table.



SECTION OF ENDURITE PAVEMENT AS LAID BY WARREN BROTHERS COMPANY.

PROPORTIONS OF SIZES OF AGGREGATE AND BITUMEN IN PRINCIPAL SPECIFICATIONS FOR ASPHALTIC CONCRETE PAVEMENTS.

Screen Mesh	Bitulithic Portland Ore. %	Asphaltic Concrete Portland Ore. %	A. S. M. I. %	Topeka %	Stone Filled %
1½ in.—½ in.	36-50	.....	.....	.....	.....
½ in.—¼ in.	12-20	5-9	5-10	10-	.....
½ in.—10-mesh	.....	.....	.....	.....	20-35
¼ in.—⅛ in.	.....	.....	15-20	.....	.....
¼ in.—10-mesh	8-12	27-31	.....	8-22	.....
¼ in.—20-mesh	.....	.....	10-20	.....	.....
10—40-mesh	.....	13-17	.....	25-55	7-25
10—200-mesh	24-32	.....	.....	.....	.....
20—40-mesh	.....	.....	10-25	.....	.....
40—80-mesh	.....	.....	10-25	.....	11-36
40—200-mesh	.....	28-33	.....	18-30	.....
80—100-mesh	.....	.....	.....	.....	.....
80—200-mesh	.....	.....	10-20	.....	7-25
Passing 200-mesh	4-7	6-10	7-10	5-11	7-14
Asphaltic cement	7½-9½	9-12	7-9	.....	8-12

First column: Screen sizes of specifications; stone passing the larger screen and retained on the smaller screen. Percentages given opposite them are percentages by weight of the total amount of aggregate. In the Topeka specification the percentage of stone passing ½-inch and retained on ¼-inch screen is "less than 10 per cent."

Second column: Percentages specified for bitulithic in Portland, Ore. Specifications vary in other cities according to kind of stone and its action in crushing.

Third column: Percentages specified for asphaltic concrete in Portland, Ore., not infringing the bitulithic specification.

Fourth column: Percentages specified in the standard specifications for asphalt concrete adopted by the American Society of Municipal Improvements. This specification is accepted by the owners of the bitulithic patents as not an infringement.

Fifth column: The so-called Topeka specification percentages, being those fixed by a Kansas district court decision as not infringing the bitulithic patents.

Sixth column: The so-called stone-filled asphalt specification percentages in use in Montreal, Que., presumably not infringing the bitulithic specification.

None of these specifications are under patent protection except the bitulithic in the first column.

The proportions given for bitulithic are those specified in Portland, Ore. Those for asphaltic concrete are also those specified for Portland, Ore. The column headed A. S. M. I., gives the proportions specified by the American Society of Municipal Improvements. The column headed Topeka gives the proportions given in the decree in the Topeka case as being a mixture which would not infringe upon the bitulithic patent. The column headed Stone Filled gives the proportions specified in Montreal, Que., for the mixture so called, which has been laid also in Schnectady, N. Y., and Milwaukee, Wis., by C. A. Mullen and is an approximation to the proportions used on the Riverside Drive, New York, which is pointed to by the Barber Asphalt Paving Company as one of their most successful installations of this class of pavement. The photograph on page 227 shows it under construction. Another photograph shows the stone-filled asphalt pavement on Mansfield street, Montreal, Que.

A pavement closely resembling asphalt concrete in structure tho differing somewhat in method of construction is endurite, laid by Warren Brothers Company. It can be laid on a concrete foundation or on an old macadam road if the surface of the macadam is scarified and brought to a uniform surface or up to grade if necessary. On the foundation thus prepared is laid 2 inches of relatively coarse stone, stone screenings and sand mixed in a suitable mixer with bituminous cement which is relatively harder than would be used on a surface exposed to traffic. This layer is not compressed, is naturally loose and open to receive a surface layer ½ inch in thickness made of sand or fine mineral matter and a large proportion of bitumen somewhat softer than that used in the lower layer. The total thickness of 2½ inches of bituminous mixtures is then rolled thoroly in one operation so that the finer mixture of the top is well incorporated in the lower layer, thus compacting them into a single layer without joint, as shown by the accompanying photograph. The fine-grained wearing surface is of varying thickness and rather thin and is so thoroly incorporated with the coarser mixture that it has no tendency to separate from it. Neither does it show under traffic as it would if it were of the usual 2-in. thickness of the wearing coat of asphalt pavement. A comparatively soft stone can be used in the lower mixture and a harder mineral matter in the wearing surface.

Constructing Bituminous Macadam Pavements.

All the above described pavements may properly be classed as asphaltic concrete. Some of the better grades of those following are so classed by some engineers, but as there is no predetermined effort in any of them to form mixtures or to select products of stone crushers which have stability in themselves, or any very close approximation to uniformity in grading of sizes, the line between asphaltic concrete and bituminous macadam is drawn at this point.

Perhaps the nearest approach of pavements of the bituminous macadam class to those of the asphaltic concrete class will be found in the specifications adopted by the American Society of Municipal Improvements for a pavement (styled bituminous concrete) with mineral aggregate composed of one product of a stone crushing plant. This specification provides that all the stone shall pass a 1¼-in. screen; that 1 to 10 per cent shall be retained on a 1-in. screen and 3 to 10 per cent shall pass a ¼-in. screen. This follows, in principle, specifications in common use for all classes of macadam pavements, tho the detail of exact sizes may differ.

The process of laying a bituminous macadam pavement is well described in the following from a paper by E. H. Townsend, engineer under the Massachusetts Highway Commission:

The surfacing was laid on a foundation of 6 in. of gravel and 8 in. of large stone fragments with about 2 in. of broken stone screened from the old macadam. Upon this was placed the 2-in. surface consisting of a mixture of broken stone and asphalt.

The stone used in the mixture was a hard local trap. All of the crusher product passing a 1¼-in. screen was used in the aggregate. The matrix material was a cut-back petroleum product with the trade name of Texaco No. 54 paving cement. This is a heavy bituminous material of specific gravity about 1.03 and a penetration of about 75.

The bitumen was to be thoroly incorporated with the stone by means of a mixing machine. The apparatus used by the contractor on this construction was a Cummer Asphalt Plant.

The asphalt and aggregate were measured to the proper proportion by weighing and each was introduced directly to the mixer from the scales. The asphalt was heated to about 350 deg. F., which temperature seemed the lowest at which asphalt of such consistency could be readily mixed with stone. The stone was heated to about 225 deg. F. This temperature is sufficiently above the evaporation point of water to insure the rapid vaporization of the moisture contained in the mass of aggregate.

As soon as the asphalt was thoroly incorporated with the stone a slide was opened in the bottom of the mixer allowing the material to drop into a waiting cart beneath. About ten batches, each containing 4 cu. ft. of stone, were necessary for one load. As the average rate of mixing was one batch per minute, 10 minutes were necessary in filling the cart. As soon as the cart was filled the mixture was teamed to the road and dumped on a steel dumping board whence it was placed on the road by shovels and brought to the proper thickness and cross-section by means of rakes. The mixture was best handled when it was placed on the road at a temperature of not less than 200 deg. F. At this temperature it was sufficiently plastic to be readily spread and rolled. A lowering of this temperature was followed by a marked stiffening or setting up in the mass with a consequent reduction in ease of handling. The rolling was kept up as close as possible to the spreading of the mixture, a space of 6 ft. to 8 ft. usually intervening between the two operations.

The proportion of the mixture as specified was 16 gal.

asphalt measured at air temperature to 1 cu. yd. of loose aggregate. This proportion was used at the start, but it was obvious at once that more asphalt was needed to coat thoroly the particles of the aggregate. Eighteen gallons per cubic yard was then tried. This proportion coated the aggregate thoroly, but it was found after placing and rolling the mixture that the surface was porous to a depth of about 1 in. In other words, after thoro compression, the pavement lacked density, due apparently to a preponderance of large particles in the aggregate. It became apparent at this time that one of the chief problems with the mixture would be the attainment of a dense surface which would seal over during the process of rolling.

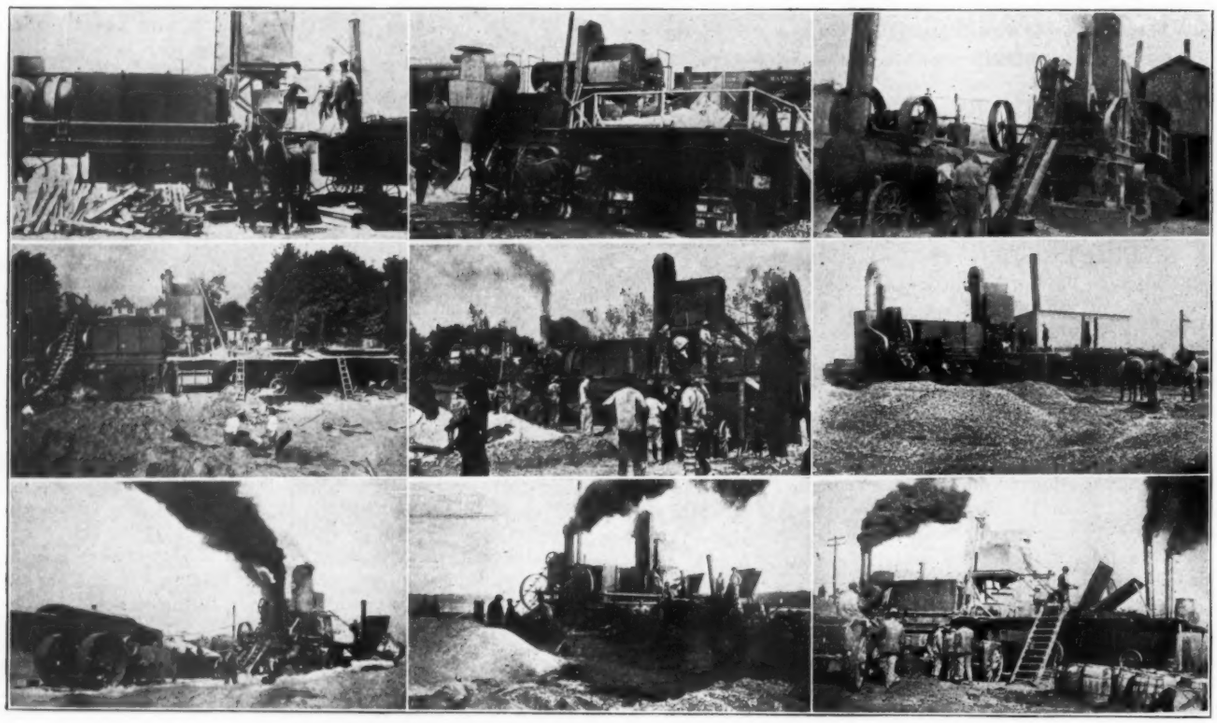
Therefore, in the solution of this problem two things were necessary, the introduction of more fine particles into the aggregate and consequently the use of more asphalt, as subquent experiments showed that a finer aggregate, having more particle surface required more asphalt to coat this surface. Some adjustments were made in the crusher, the jaws were set closer and the method of screening was changed. The result was that the output contained a larger percentage of fine particles. This required the use of more asphalt per cubic yard of stone and the amount was increased from 18 to 20 gal. and then to 21 gal. The resulting pavement was denser than the first experiments and showed a much greater tendency to seal over under rolling. The surface, however, was still porous, the top particles protruding from the denser part of the pavement from ¼ in. to ½ in. There apparently was no other way of obtaining a denser pavement with the aggregate available. Further adjustments of the crusher resulted in no appreciable increase in the amount of small particles in the aggregate and the introduction of more asphalt into the mixture was found to be impossible. The aggregate was supplied with as much bitumen as it would carry, for additional asphalt ran out of the mass and was lost in transit.

The specifications made no allowance for the introduction of a finer material by adding to the aggregate a sand or fine crusher product. We were restricted to the use of a crusher run and after experimenting with the product until the aggregate contained the least amount of voids, as nearly as could be determined without actual analysis, we still had a pavement which was porous on the top and doubtless would soon pick up under the heavy usage of the traffic. Furthermore, the entire pavement was opened to penetration by moisture and the resulting disintegration caused by water standing on an asphalt surface.

The use of a flush coat to seal over the surface and obtain a water-tight pavement was determined upon, and the same kind of asphalt was used as in the mixture. The asphalt was applied to the surface from pouring pots and wiped down to a uniform thickness with squeegees, care being taken to pour and to carry the strokes of the squeegee lengthwise of the road.

As little asphalt was used as would insure sealing over the surface, this amount being about 2/3 gal. per square yard. It was found that the asphalt was most easily wiped down to a uniform thickness when it was applied at a temperature not less than 375 deg. F. Immediately after application it was covered with a clean ¼-in. grit, spread at the rate of about 20 lb. per square yard.

The applying of the flush coat was performed as close to the spreading of the mixture as possible. By so doing the



CUMMER PORTABLE ROAD ASPHALT PAVING PLANTS IN OPERATION.

AS OPERATED BY F. J. McGUIRE, CONTRACTOR, NORFOLK, VA.

AS OPERATED BY PACE BROTHERS, CONTRACTORS, CLEVELAND, OHIO.

AS OPERATED BY EDWARDS CONSTRUCTION CO., TAMPA, FLA.

AS OPERATED BY CITY OF PROVIDENCE, RHODE ISLAND.

AS OPERATED BY FULTON COUNTY COMMISSIONERS, ATLANTA, GA.

AS OPERATED BY D. J. RYAN CONST. CO., CONTRACTORS, DAVENPORT, IA.

AS OPERATED BY WESTERN PAVING CO., CONTRACTORS, SEATTLE, WASH.

AS OPERATED BY GEO. F. BRACKETT, CONTRACTOR, CLIFTON, N. J.

AS OPERATED BY MUNICIPAL PAVING CO., NASHVILLE, TENN.

advantage of placing the flush coat on a clean, warm surface was gained. In gaining this advantage the use of a pressure distributer was precluded. It should be kept in mind that no penetration of the stone was required, as all particles were already coated. The mere sealing over of the surface was the end in view and the method of application adopted was apparently effective in attaining this end.

At the time of applying the flush coat was scarcely 1/16-in. in thickness. The action of the traffic gradually pressed the covering of grit into the flush coat until it became a part of the wearing surface. The result was that the flush coat by the addition of this grit increased in thickness to ¼ in. to ⅜ in.

The resulting surface is similar in appearance to some patented pavements of similar construction. It has a smooth, rubbery appearance peculiar to asphalt surfaces, which appearance is probably pronounced in the case of surfaces constructed with a mixture and finished with a flush coat.

During the warmer months of the year the surface was sufficiently receptive to give a good footing for horses. But when the weather is colder the pavement becomes hard and slippery, not so much so as a sheet asphalt or wood block pavement, but enough to give insecure footing for horses hauling heavy loads on the grades. This condition is not unusual in pavements of this type and can probably be remedied by the application of a coarse grit during the warm period when the pavement is sufficiently soft to receive this grit under the pressure of the traffic.

This description shows the difficulties which are met in the construction of bituminous macadam under the simplest specifications and the reasons for the modifications which have been made in such specifications in proportioning the sizes of stone as far as legal restrictions will permit, in adding fine material, in putting comparatively fine material in the wearing surface, in using a seal coat, and in the methods of operation of the paving plant to secure the desired results.

The temperatures and conditions named were worked out in the field for the bituminous cement actually used in the work. They should be changed more or less if other cements are used according to their characteristics. These changes are given in considerable detail in the specifications of the American Society of Municipal Improvements next above quoted, unfortunately without giving the names of the asphalts and tars which are covered respectively by the five specifications given for asphaltic cements and the two specifications for refined tars. Any of these seven bituminous cements are satisfactory for use in bituminous macadam pavements, but they cannot be selected properly or used according to a blanket specification broad enough to cover them all. Hence the seven specifications.

There are many specifications for this class of pavement, producing all grades of results, but out of the many experiments and trials standards are gradually emerging such as those referred to.

Penetration Method.

The points to be considered in the use of bitumens in the penetration method of constructing bituminous macadam pavements are briefly stated in the following extract from a letter written by Walter H. Flood, chemical engineer, Chicago, Ill.:

Bituminous macadam is best constructed by applying the heavier bitumens after being properly liquefied by heat evenly and uniformly upon successive layers of broken stones which have been placed upon a sufficient foundation, each layer being properly rolled by steam roller until of uniform contour and well compacted. The bitumen should be applied by mechanical sprayers so constructed as to force the material as deeply as possible into the voids or interstices between the stones so as

MOTOR DISTRIBUTER APPLYING BITUMEN TO SURFACE OF ROLLED BROKEN STONE LAYER IN CONSTRUCTION OF BITUMINOUS MACADAM PAVEMENT.

to cover thoroly each fragment of stone with bitumen on all its angles. The successive applications will then form a homogeneous mass thoroly compacted and cemented together with bitumen. The surface is finished by applying stone chips or clean, sharp gravel. Each layer should be thoroly compacted by rolling and the bitumen applied under pressure at as high a temperature as practicable without injury to the material. The total amount of bitumen used in all the applications will average one to two gallons to each square yard of surface, dependent upon the grade or viscosity.

In bituminous road construction there are probably more factors to be taken into consideration than in any other type of paving; for the life of the pavement depends not only upon the quality of the bitumen, but also to a very great extent on the correct grading of the mineral aggregate and proper handling of the materials. Naturally, the different types of construction will require bituminous cements of different characteristics. Other factors such as climate and traffic also materially affect the requirements of the bitumen.

On penetration macadam roads the bituminous material will of course be of relatively soft consistency. With asphalts the penetration will depend upon traffic and climatic conditions and also upon the nature of the asphalt itself. In colder climates a softer material should be used, while a much traveled road will require a somewhat harder asphalt than one subjected to less traffic. An asphalt such as the California types, which are considerably affected by temperature changes, will require to be used softer than those not so affected in order that it will not become too brittle in cold weather. Trinidad asphalt, on the other hand, is laid at a harder consistency, as its mineral matter naturally would tend to lower the apparent penetration of the bitumen.

The nature of the aggregate is another factor which in-

fluences the asphalt. Large stone having greater stability than small material, will take a softer asphalt, and one with less ductility might be used than where the aggregate is relatively fine.

In the handling of all kinds of bituminous materials which solidify or partially solidify when cold it is first essential that such material be properly liquefied by heat in order that it may be sprayed or otherwise distributed upon the road surface. When properly heated the material may be readily and most efficiently sprayed, preferably under pressure, by mechanical sprayers. Many kinds of apparatus have been devised for this purpose in this country and abroad. It is, however, the consensus of opinion that the most practical apparatus is a distributer which will properly heat the material and distribute it in the form of an atomized spray in volume as desired, under artificial pressure, the advantage being that the pressure forces the material into the voids between the stones much more thoroly and effectually than gravity. The apparatus should be constructed to be drawn by horses, automobile or traction engine and should be adapted to the varying conditions under which it may be used. For road construction it is important that the distributer be drawn by a tractor or auto rather than by horses, as the horses disturb the prepared or rolled stone surface. On the other classes of work—resurfacing, repairing or dust-laying—the machine may be handled either by automobile or horse power. The apparatus should be so constructed as to distribute properly any and all kinds of bituminous material, either hot or cold, and in volume as desired.

Pumps for furnishing pressure are in general use. Both the automobile and horse-drawn types of the distributer are also equipped with heating and circulating systems insuring heating efficiency with no liability of injury from overheating material.

In handling the heavier grades of bituminous materials requiring high temperature no moisture should be allowed to come in contact with the material in the process of heating. A little water will cause the bitumen to foam and become useless for road work. Leaky steam pipes have this effect. Direct heat from kerosene oil burners or wood fires conveyed thru tubes placed in the interior of the tank reduces the danger from moisture and from overheating.

In distributing the bitumen precaution must be taken to prevent walking or driving over it before it is covered with sand, otherwise bare spots will be exposed which will have to be patched up before the road can be finished.

The excessive use of bituminous material should be avoided. It results in uneven and wavy surface and will exude toward the shoulders of the road.

The following description of the construction of a bituminous carpeted macadam road gives a full statement of the process of constructing one of the cheaper forms of bituminous macadam penetration method. It is by Henry Marshall Olmsted, highway engineer, Brooklyn, N. Y., and is a more than usually practical article regarding details. It appeared in a recent number of *Good Roads:*

In July of last year the writer commenced the construction of a road in Bayonne Park, Bayonne, N. J. The road is about 1.17 miles long and is 30 feet wide except on one section about 800 feet long, where the width is 35 feet. The date of the start of the work is given because of its bearing on the methods of construction.

The roadway consists of two courses of broken trap rock carpeted with Tarvia B and washed pea gravel. The stone used was Rockland Lake (N. Y.) trap rock having a specific gravity of 3.0. The stone used in the bottom course was known as 2½-in. stone, and was defined by the specifications as stone passing a 3¼-in. ring and retained on a 2⅛-in. ring. The 1½-in. stone used in the top course was broken to pass a 2¼-in. ring and to be retained on a 1⅛-in. ring.

Frequent tests of the size of the stone were made with a pocket tester consisting of a piece of pine wood ¼ in. thick in which were bored holes, one 3¼ in., one 2⅛ in., one 2¼ in. and one 1⅛ in. in diameter. The results of two tests of 1½-in. stone are given in the following tables:

TEST OF MATERIAL FROM BARGE NO. 3.

Size of Stone.	Number of Stones. Test No. 1	2	3	Total.	Percentage.
Proper size	40	47	34	121	42.5
Under size	38	26	39	103	36.2
Thin slabs	14	27	20	61	21.3
Total	92	100	93	285	100.0

TEST OF MATERIAL FROM BARGE NO. 4.

Size of Stone.	Number of Stones. Test No. 1	2	3	Total.	Percentage.
Proper size	79	95	100	274	66.0
Under size	17	60	45	122	27.0
Thin slabs	3	13	15	31	7.0
Total	99	168	160	427	100.0

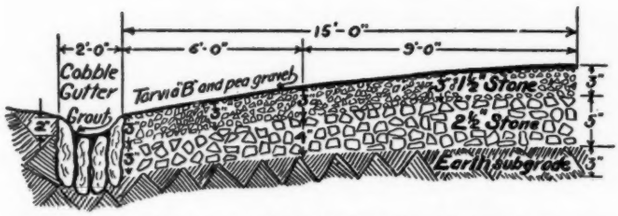
The material from barge No. 3 was rejected and that from barge No. 4 was accepted. At least 75 per cent. of the stone for the top course should be of the proper size, that is, out of 100 stones picked up at random 75 should meet the ring test as to size. Strikes, delays, lateness of the season and conditions beyond control forced our acceptance of some stone only 35 per cent. to 50 per cent. perfect.

Prior to the writer's connection with the work there had been ordered trap rock screenings designated as "¼-in. to ½-in. particles free from dust." A few loads were delivered, but satisfactory results could not be obtained with the material. It would not enter the voids and possessed no binding value. It was finally rejected and the screenings from ⅛-in. to ¼-in. in size and dust, the latter amounting to about 30 per cent. of the entire volume, were used. These screenings possessed sufficient cementing power to hold the stone in place until the application of the "carpet" and gave good results.

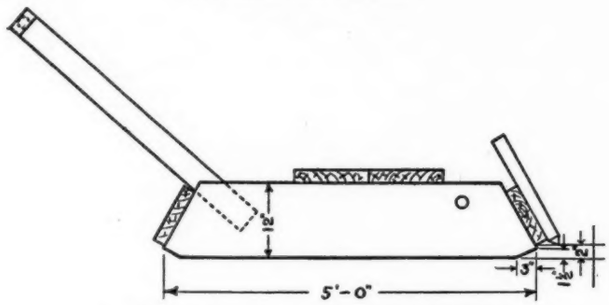
The material was delivered to the work by 2½-yd. dump wagons and 5-yd. Packard motor trucks. As a rule six teams and two trucks were used. The distance from the dock to the work was 2 miles. The trucks made 20 round trips daily, delivering 100 cu. yds. at a cost of 10 cents per cu. yd. The teams made 7 round trips a day, delivering 17½ cu. yds., at a cost of 30 cents per cu. yd. The trucks were valued at $5,100 each and the teams at $800 each. In addition to the cheaper transportation cost with the trucks there was a decided advantage in placing the stone, as the trucks spread the stone on the road in a long ribbon of any required thickness.

In the construction of the road it was necessary to rebuild only a few parts of the sub-grade. The stone was generally spread by the wagons or the trucks, but it was occasionally necessary to dump the stone in piles, shoveling it on the road later and bringing it to the proper thickness and proper level. The first course before rolling was 4 in. deep at the gutters, 5 in. deep at the shoulders and 6 in. at the crown. The rolling reduced this to 3 in. at the gutters, 4 in. at the shoulders and 5 in. at the crown. The second course was spread 4 in. deep over the entire road and rolled to 3 in., making the thickness of stone in the completed road 6 in. at the gutters, 7 in. at the shoulders and 8 in. at the crown.

The loose stone was spread to the required thickness by means of the stone leveler, designed by the writer. A side elevation of this is shown in one of the accompanying sketches. It consisted of two runners of 1½-in. plank, 5 ft. long and 12 in. high, placed upright side by side and held 7 ft. apart, with pieces of 1½-in. plank at the ends for spreading the material. The end runners were shaped at the front and back as shown



CROSS SECTION OF PARK ROADS—HORIZONTAL SCALE ¼ VERTICAL SCALE.



SIDE ELEVATION OF STONE LEVELER

in the sketch. The cross plank at the front acted as a plow, but at the same time allowed the stone to flow under it, while the cross piece at the rear dragged the stone along for a way and then permitted it to slide under the edge. To facilitate the plowing action a 2x4-in. stake, pointed at the lower end, was attached to the center of the front cross piece. The leveler was drawn by two horses hitched to the leveler by chains thru the holes in the front of the side pieces.

On a measured area of 1,000 sq. yds. covered with irregularly piled stone heaps, 2 and 3 ft. high, the stone was leveled to a thickness of 4 in. in 3 hours at a cost of $2.10. To do this by hand would have taken 20 men 9 hours and would have cost $40. Wood blocks, 4, 5 and 6 in. high, set on the road, were used to guide the laborers in leveling. The rolling was done with 12-ton rollers. The sub-grade was thoroly rolled and the bottom course of stone was rolled five times before placing screenings. The roller was started at the gutters and worked up to the crown by 8-in. laps of the rear wheels. After rolling the bottom course a 1-in. layer of screenings was applied by shovels from piles along the road. The best results were obtained by covering the area to be filled lightly several times, rolling while spreading was in progress. In damp weather the screenings stuck in the upper part of the stone course and had to be worked down into position by means of fiber push brooms. After the lower course had been filled the screenings were broomed off and out of the surface to a depth of about ¼ in. in order to leave the stone sticking up to form a bond with the second course. About 1 in. of screenings were required for the lower course. After the screenings were all in place the surface was watered. A 700-gal. sprinkling wagon was used and was run about five times over the first course.

Screenings to a thickness of ¾ in. were required for the top course. They were worked into the stone by the same methods employed for the lower course. After filling this course it was watered, about eight trips of the sprinkler being made. The course was again rolled and a thin layer of screenings applied to the surface, leaving screenings to a depth of ⅛ to ¼ in. remaining on the road. The adequacy of the rolling was determined by the "feel under foot," by the "feel conveyed to feet of roller man," by "watching rear wheels and noting that surface did not creep or give," and finally by the change in the color of the surface from a solid to a dappled gray, the white spots being the tops of stones beginning to show.

After the completion of the macadam all dust and surplus screenings were brushed from the surface, first with wire push brooms and then with fiber push brooms. This exposed the surface stones to a depth of about ⅛ in. On completing this operation the necessity for perfect 1½-in. stone became very apparent, as smaller stones would be broken loose from the surface by the operation. In one part of the road where under-sized stone had been used, we were obliged to dig out the old material, put in fresh screenings, roll, water and roll again and then broom the entire area a second time. This sweeping of the surface removed from the total area of 21,500 sq. yds. about 12 wagon loads of surplus screenings which I later used again. After brooming, the surface presented a rough, uniform surface. A part of the screenings were used to form ridges on the inside of the gutters to prevent the surplus bituminous material from running into the gutters.

The material for the "carpet" consisted of Tarvia B, which was applied from a 1,200-gal. motor distributer. The material was applied thru spray nozzles under 20 lbs. pressure. Four trips were required to cover the 30-ft. width of road. The material was applied hot when the road was perfectly dry, the penetration being about ½ in. The material was applied at the rate of about 0.5 gal. per sq. yd. In mild, sunny weather the Tarvia was allowed about 24 hours to penetrate the road, but in damp weather about twice as long.

The Tarvia was covered with clean washed pea gravel free from sand and consisting of particles 1/16 to ¼ in. in diameter. This was applied from piles placed on the side of the road, 1 cu. yd. covering about 100 sq. yds. of road surface. After application the gravel was leveled by wooden garden rakes, any over-sized particles being removed at the same time. The road was then rolled twice, the dust ridges removed from the gutters, and the road opened to traffic.

The cost of the work per square yard, exclusive of grading, the building of gutters, bridges and drains, was as follows:

Stone	$0.3851
Screenings	0.1220
Pea gravel	0.0200
Tarvia B	0.0459
Teams	0.0160
Rolling	0.1030
Labor	0.3080
Total, per square yard	$1.0000

Under favorable market conditions the work could have been done for 75 cents per square yard. The estimated cost of maintenance is $300 per year, or 1.4 cents per square yard annually. This indicates a total cost at the end of ten years of $1.14 per square yard.

Municipal Garage at Grand Rapids, Mich.

A system of cost accounting is a necessary part of the economy of a municipal garage such as is described in this article. The accounting system shown requires a minimum of time to keep it and could well be more detailed, particularly as to certainty and fullness of daily reports. MUNICIPAL ENGINEERING *believes this work to be of so much importance that it has devised a system of daily reports with monthly and annual summary sheet for the convenience of its subscribers.*

WITH the operation of a municipal garage and a comprehensive system of cost accounting, the board of public works at Grand Rapids, Michigan, has increased the efficiency of the department by a generous per cent. The features have not only given the department as a whole a higher standing, but they have solved the problem of motor truck operation and placed this branch on a smooth-running basis. Cutting the cost of maintenance and operation, preventing loss from both the inside and the outside, and organizing all movements to an advantage—these are the results that the double plan has achieved.

The garage is a fireproof building, 53 feet by 86 feet in dimensions, adjoining the repair shop of the water works department. The thirteen trucks in service are operated entirely from this central point. Two specially constructed cars are used by the highway and street repair departments for trimming electric lighting wires; one large car for construction work, and eleven small capacity cars for repair work and service. All calls for work, repairs and service are placed with the foreman of the garage by the heads of the various departments. He transmits the orders to the drivers and operatives. This feature alone, by focalizing the various endeavors, is the medium for a great saving of time.

A skilled automobile mechanic serves as the foreman of the garage and directs the work of three sub-mechanics. Repairs on cars are negotiated easily, at the lowest possible cost for materials. Any special work of an unusual nature requiring large machines is done in the regular repair shop of the department. The garage has a repair pit, a complete outfit for vulcanizing tires and an acetylene gas welding outfit. The pit is equipped with electric lights and provides for the highest grade of workmanship. Vulcanizing and repair on tires is done as well as, if not better, than it would be at a public garage. This is also true of the welding. Drains and wash pits are provided and it is required that each driver shall wash his car at least three times a week. This is in conformity with the idea that the public's impression of any municipal department counts for much, and cleanliness in equipment has much to do with creating the favorable impression.

All gasoline and oils are stored in the garage and no driver is permitted to secure a supply of either without passing a requisition thru the foreman. These requisitions are then turned in to the department heads and checked back once a month. The plan obviates all waste and losses thru injudicious buying. Money is saved on the initial purchase of the oils as well as on all repair parts and necessities, a better price being obtainable in quantity lots. Formerly, where private garages were patronized, the city was constantly victimized by unscrupulous dealers. Figures computed by Lewis D. Cutcheon, general manager of the board of works, show a saving of over 25 per cent. on all expenses.

On repair work the saving has kept pace with the buying expense. The time of the employe is saved because he is required to lend his efforts to the task where, in a private garage, he would be watching another workman do the duty. No time is lost on any job, the chief idea being, under the direction of the foreman, to get the truck back into service as soon as possible. Especially is this true in the case of tire trouble, changes being made in very short order.

In connection with the garage, and a contributing feature to the increased efficiency of both the garage and the departments, is a complete cost accounting system. A large card (Fig. 1) for every car is kept at the garage and each night, before a driver leaves for home, an actual account of the day's operations and expenses is noted. All repairs and running expenses are jotted down, including the daily reading of the speedometer, the amount of gasoline and cylinder oil used, the character and kind of any repair work that is done, punctures to tires, blowouts and displacements, in fact, every

Arc Trimmer #2

Board of Public Works Auto. Report Card, Month of Nov. 1916

DAY 10/31	SPEEDOMETER READING 5121	Miles Per Day	GASOLINE Used	GASOLINE Rec'd	CYLINDER OIL Used	CYLINDER OIL Rec'd	REPAIRS	TIRE REPORT
1	5152	31		5		1 qt		
2	5185	33		5			4 spark plugs	
3	5215	30						
4	5258	43		5				
5	Sunday							
6	5286	28		5		1½ qt		2-30"x3½"
7	5317	31						outers.
8	5357	40		5		1½qt		
9	5390	33		5				
10	5421	31		5				
11	5485	64		5				
12								
13	5516	31						
14	5555	39		8		1½qt		
15	5593	38						2-31"x4"
16	5628	35		5		1 qt		outers
17	5651	23						
18	5714	63						
19	Sunday							
20	5751	37						
21	5787	36		5				
22	5826	39		8		2 qt		
23	5877	51						
24	5884	7						
25	5899	15					2 spark plugs.	
26	Sunday							
27	5939	40		8		2 qt	I Radiator hood	
28	5976	37					I set skid chains	
29	6033	57		5				
30	Not operated.							
31								
Totals		912		79		10½qt		

Entries on this report must be made every day when day's work is finished, and card left where machine is kept.

Operator will return card to office on first of each month. In Repair Space note nature of repair and by whom made. In Tire Space note punctures, blow outs or replacements, giving No. of wheel. If machine is in trouble notify office at once for instructions.

No. 1 8 No. 2 8

Drive O

Sign Harry Amstutz.

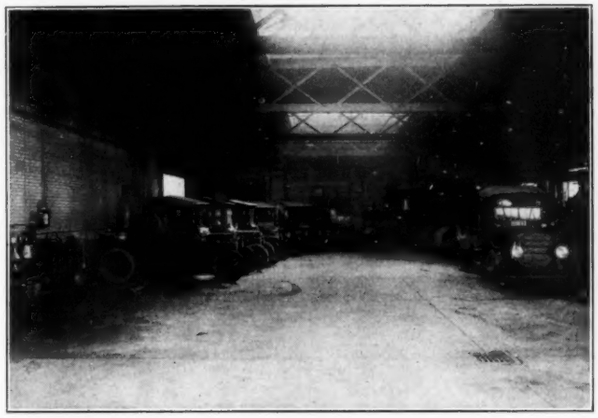
Auto No. 1127046

0300329 No. 3 0282988 No. 4

License No. 12

feature of the day's activities. At the end of each month these cards are turned in to the city accountant and checked. Thus an accurate check is had on every expense of truck operation, and this, in turn, may be used as a check against all purchases made and time used. It also provides for a complete set of figures on cost and operation for any budget figures to be submitted to the city at the end of the year.

It is figured that the garage alone has worked untold value for the city from the standpoint of centralization. It makes it possible to dispatch the trucks on work without loss of time that would certainly occur without the focal arrangement. With the constant cry of the public for service, the department has more than ingratiated itself in countless instances. This time saved also constitutes a saving in money and a consequent agreeable situation. With the accounting system, and its saving of more than 25 per cent. of expense in operation and maintenance, the idea has a double value. It has grown into recognition as an institution and its permanency, as one of the city's best assets, is assured.



MUNICIPAL GARAGE AT GRAND RAPIDS, MICH.

SHOULD A STEAM BOILER BE COVERED?

By F. Webster Brady, Electrical and Mechanical Engineer, Scranton, Pennsylvania

It often happens when equipping a power plant that some very excellent apparatus is selected, but it is installed in a way that prevents its full efficiency from being attained. In case the theoretical expectations are well known, the results will cause disappointment. In fact many engineering ventures are wrecked because they are built on a half-truth for a foundation. In most instances, however, the losses are not realized, owing to those in authority not having any engineering training. They operate with the peaceful idea that "what you don't know doesn't hurt you."

An illustration of a loss with satisfaction is shown by the case of a marine type of boiler as found in a municipal water works plant. This boiler has been operated for several years without any covering. Its purchase was recommended by the plant operator, when an extension of the water works became necessary, as it was claimed that this boiler was self-contained and complete so that no extras would be needed to install it. Also, by means of its two 3-foot Morrison furnaces the fire is "inside the water," which gives a greater efficiency.

Thereupon, an exact appropriation was made by the City Fathers to cover its purchase and installation ready for service. As the boiler is of high-grade workmanship, there has been no trouble in its operation, and everyone has been satisfied—excepting for one little ripple on the sea of municipal happiness.

An agent for boiler coverings came along one day and tried to show the "powers that be" what a great saving of fuel would result from covering the boiler. The estimated cost of the covering was $150. However, it was not purchased for several reasons: First, the boiler had been bought as a complete unit and all the appropriation was expended; second, the fireman said he could easily keep up steam, and the boiler was so efficient that a covering was not necessary; and third, no one could see any loss. So the matter was dropped and the plant has been operated without any interruption ever since.

However, a condition of this kind in a plant always brings up a question in the mind of the front-line engineer, namely, "Will it pay to cover this boiler?" After figuring out the problem the readers who are operating engineers will likely take a look over their plants to see if there are any economies possible. The plant herein described is not an isolated case by any means. It is a type that is quite common, and the subject of coverings does not apply only to steam boilers.

The following is one method of working out the problem:

Boiler diameter, 9 feet 6 inches; length, 12 feet. Area of boiler shell that could be covered, 9½ by 12 by 22/7 feet, or 358 square feet.

To this area should be added about 12 square feet that could be covered on the ends, making a total of 370 square feet.

Steam at 175 pounds gage has a temperature of 377 degrees Fahrenheit, and if the average boiler room temperature is 77 degrees, the net difference will be 300 degrees. Tests have shown that the heat loss from uncovered boiler plate is as much as 3 B. t. u. per degree difference per square foot per hour. Also, it has been found that a good covering will reduce the loss to about .4 B. t. u. Therefore, the gain from the covering in this case would be (3 minus 0.4) by 300, or 780 B. t. u. per square foot per hour. The total heat saved per hour will be 780 times 370, or 288,600 B. t. u.

This plant is operated 18 hours per day, and the fires are banked for 6 hours, and for half time, or 183 days per year. The estimated heat loss per year that could be saved by the boiler covering is 288,600 times 18 times 183, or 949,648,400 B. t. u.

The coal used is an excellent quality of run-of-mine bituminous, costing $2.25 per ton delivered. With a boiler efficiency of 70 per cent this coal will surely produce as much as 9,500 B. t. u. per pound. If so, then the yearly loss is equivalent to 949,648,400 divided by 9,500 and multiplied by 2,000, or 50 tons. This coal costs $112.50, or nearly the same as the boiler covering. It should be understood that this estimated saving might not be entirely realized in practice. The boiler covering would either deteriorate or become cracked in service and less heat would be saved. It seems possible, however, to save from $75 to $100. If so, is it worth while to cover this boiler, or any other one doing similar duty?

CONSTRUCTION OF VITRIFIED PIPE LINES

By J. F. Springer, New York City.

This article, while quite elementary in its nature, collects together some details of construction in convenient form for use and may aid both engineer and contractor. It is one of a series of articles by the same author which has appeared at intervals.

THE basic material used in the manufacture of vitrified sewer pipe is either shale or clay. As it is not general practice to ship such pipe long distances, the character of the basic material will vary for pipe made and used in different parts of the country.

The preparation of the shale or the clay before molding has much importance. For example: The amount of surface pimpling on salt glazed pipe is less when clay is used that has been passed thru a 16-mesh screen than clay which had been passed thru an 8-mesh screen. A finer screen gives but little better results. The experimenter responsible for the foregoing discovered, or was of the opinion that he had discovered, that pimpling was due to "the incipient fusing, bubbling and swelling of small particles of shale, lying close to the surface of the pipe." Other makers of pipe found that pimples apparently arose from the oxidation during burning of the iron contained in the clay. The pimpling may be reduced by the proper management of the temperatures during the burning process and by carrying out the glazing only at a time when the flame is good and clear.

After clay pipe has been molded to form it is allowed to season under cover to give opportunity for a reduction of the water content by natural means. A slow drying and burning in the kiln is the next procedure. During this period the defects known as fire cracks develop. These may zig-zag more or less, but usually they have a general circumferential direction. They are possibly caused by sudden local changes of temperature brought about by the direct action of hot flames or cool currents. Another type of defect is the network of water cracks, thought to be due to a too rapid heating at the beginning of the kiln operations. Blisters are probably due to improper heating at the beginning.

As vitrification proceeds heat cracks of all kinds are brought into evidence by the shrinkage attendant upon vitrification. A single fire crack is not to be regarded as a fatal defect, it being permissible to have one at the spigot ⅛ inch wide, 2 inches long and penetrating the full thickness of the shell. Blisters on the interior, if unbroken, not higher than ¼ inch, and having a diameter of say 2 inches, do not warrant condemnation of the pipe section.

Since nearly all classes of defects may either be eliminated or reduced in amount by proper manufacture, considerable care ought to be given to any deserved reputations of concerns within a practicable shipping distance of the point of use.

In England, a distinction is made between sewer pipe made from fire clay and that called by them stoneware pipe. This latter is rated as "stronger and better able to resist the decomposing effects of the sewage." The pipe is salt-glazed inside and out, except on the surfaces of bell and spigot where the jointing material comes into contact with the pipe. Here an unglazed surface is preferred.

The British have devised a form of spigot end which prevents carelessness in setting spigots out of center with the bells in which they are inserted. The spigot end is given a slight flare and it is only necessary to force the pipe well home. An additional advantage is a reduction in amount of jointing material required.

Vitrified sewer pipe not being well adapted to perform the service of a beam, they should be supported evenly when in place along their length and generally all over the under surface. Hard spots in the supporting soil may easily convert the sewer into a series of short beams. Ordinarily, it is not considered good practice to place vitrified sewer pipe immediately upon rock. The latter is excavated for perhaps 6 inches below the sewer level and a filling of gravel or fine material put in. At the bells it is sometimes required that the full depth of the softer material be maintained, requiring bell holes in the rock.

Sewers of vitrified material sometimes give way because of the overhead load. In such cases, following the theory of stresses, the pipe breaks into four longitudinal pieces, each of which is roughly a quadrant of the circumference of the pipe. The points of breakage are at the ends of vertical and horizontal diameters. "For this reason fire cracks and slight imperfections which do not cause the rejection of a pipe should be placed at a point about 45 degrees above the horizontal in laying, and not at the top."

The pressure of the back fill on top of the pipe may be reduced in many cases by sharply narrowing the trench at a level somewhat above the top of the sewer. The ledges or berms thus produced become the resting places for the ends of an earthen arch. The natural narrowing of the trench in excavating aids this arching action even if the berm is not formed. The narrowing is sometimes so great that local enlargements in the excavation must be made for the bells.

The tamping iron used in filling in the space around the pipe should be given a weight of not more than 7 pounds. It is recommended that the tamping face be not greater than 1½ by 5 inches. "A tamper of even smaller size made be used to advantage until the filling is brought well up above the springing line of the pipe."

With small sizes of pipe, the side thrust is probably negligible or nearly so in most cases. Such pipe will carry a full overhead load of, say, 8 or 10 feet of backfilling. But the nature of the backfilling will cause variations in the character of the load transmitted to the pipe. Gravel will often tend to form an arch. Its weight will accordingly be partially removed. Clay when wet forms a rather poor arch, so that the load transmitted is a large part of the overhead weight.

A thin covering of backfill transmits loads moving on the surface over the sewer, such as loaded wagons, road rollers, etc., whereas with deep fills these loads will be distributed at the sewer level so that the sewer itself will get but a small share, if the arch action does not take up the moving load entirely.

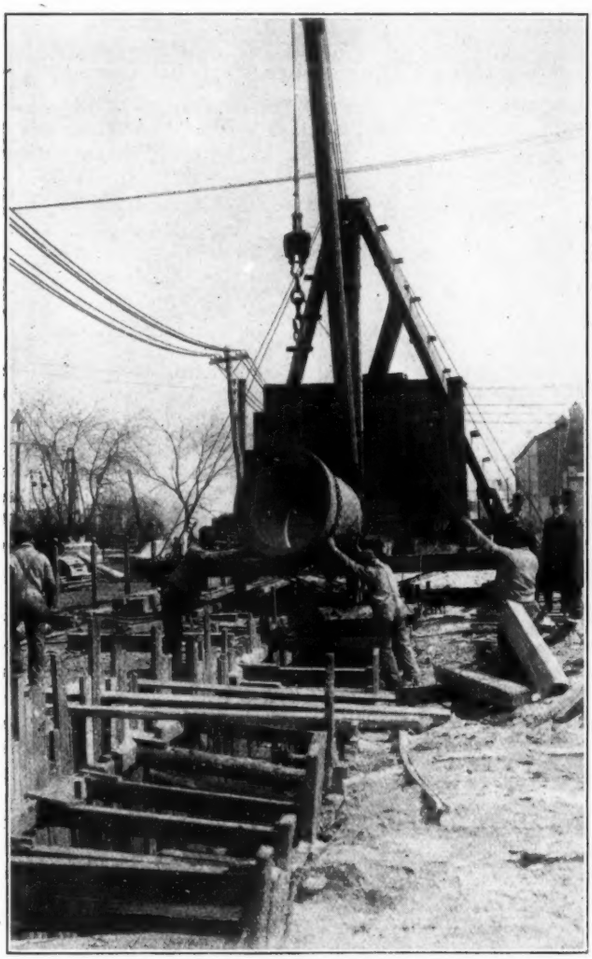
Much trench tamping is now done by machinery. The apparatus used at Wilmington, Del., was provided with a vertically moving ram having a tamping face 8 inches square. The ram is provided with a long vertical rod, to whose sides are secured contact strips of wood. Two cams rotate continuously in opposite directions. When the high parts come around close together they grip the rod and lift it until the high parts pass. Then the ram drops and gives the tamping blow. A gasoline engine runs the apparatus, which, operated by two men, does the work of five or six men. Hand tamping is used for 2 or 2½ feet up from the springing line and above that the machine is employed.

The laying of vitrified sewer pipe often becomes rather difficult when the trench is in water-bearing soil. Wakefield wood piling may be made water-tight and can be made from material

close at hand. Steel sheet piling drives easier than wooden piling and thru more difficult soils. Some types are reasonably water-tight, and other types require plugging, which may be done in rather simple ways. Steel piling may be obtained in very light weights, so light, in fact, that 10 or 12-foot lengths many be handled by one man. If the soil is not too difficult, light-weight piling may be driven by hand, a maul or light hammer being used. It will often be necessary, however, to use a steam or air hammer, or some other means of striking a heavy blow. Such apparatus may be quite portable. It is set up on top of the pile to be driven. Sometimes there will be a step upon which the operator may take his stand, thus adding his own weight. Steel sheeting may be driven by a derrick pile driver, and such apparatus may be mounted on a scow for a sewer line across a body of water. Two parallel lines of piling may be put down and carried out from the shore to some convenient point in the water. A few piles will then be driven to form a transverse wall connecting the two lines. The material in between may sometimes be excavated by hand and often by orange peel buckets. The excavated material may be piled up against the steel sheeting on the outside and thus aid in making it water-tight. By pumping out the interior space excavation may be continued comparatively dry. An impervious stratum may be expected not far below the bottom of a body of still water, and if not too far down the piling can be driven down to it, thus relieving the difficulty of water coming up thru the bottom of the trench.

Vitrified pipe must sometimes be laid upon a concrete bed. H. S. Watson, a British sewer engineer, gives the following

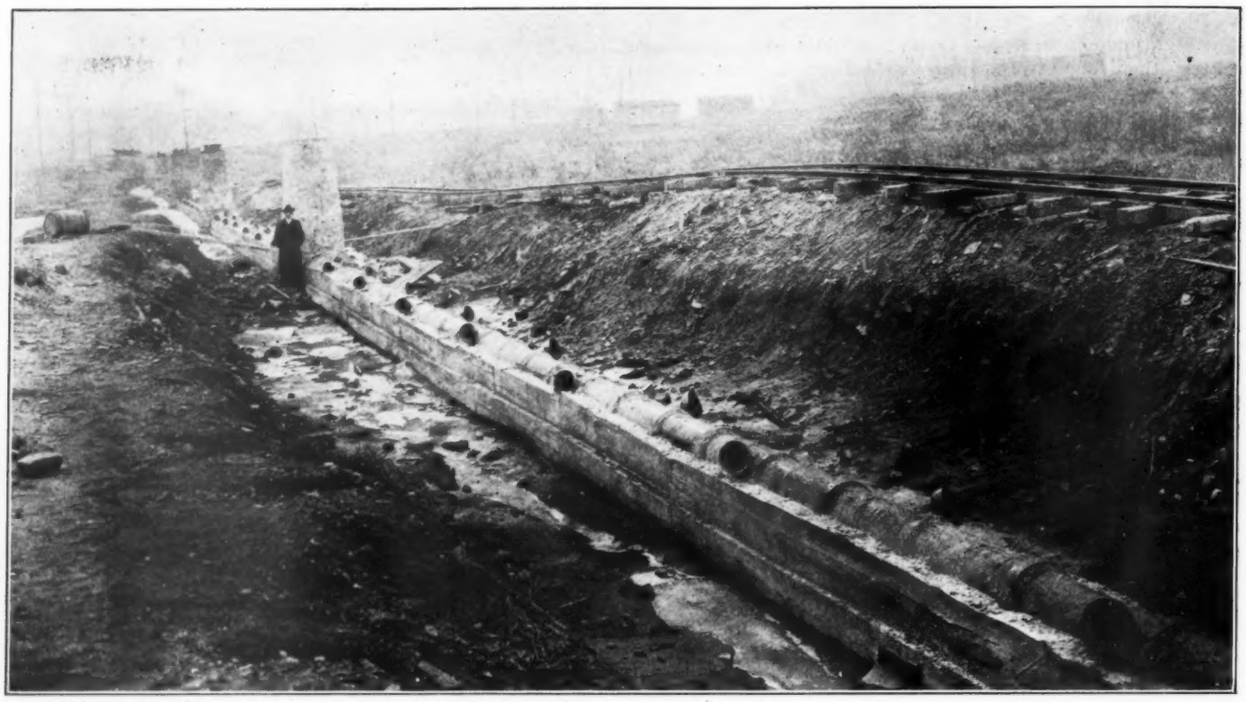
VITRIFIED SEWER ACROSS SALT MARSH IN SHALLOW TRENCH, BORO OF BRONX, NEW YORK.



LOWERING LARGE SEWER PIPE INTO PLACE, BORO OF BROOKLYN, NEW YORK.

method: A number of bricks are laid flat at distances from each other of about 10 feet. The upper surfaces are set carefully below the invert levels, the thickness of the pipe wall lower than the corresponding levels of the invert. Concrete is then filled in until it reaches the top of the bricks, and is leveled off to the exact grade with a straight edge. The concrete is now allowed to set for, say, two days, if the ground is dry. Bricks to serve as reference marks will now be set on edge aside from the center line 10 feet apart and worked into the concrete to bring the upper edges exactly to the invert level.

The pipe is now laid, bells uphill, beginning at the lowest point of the section. Back of each bell a brick is set to support the pipe. This brick will be laid flat or set on edge according to the amount of projection of the bell. A line of pipe will thus be set upon a line of bricks, one brick to a pipe length. As this line of pipe grows in length the jointing is begun by three men. First, the pipe layer applies cement to the lower part of the joint. He does this in such way as to make bell and spigot concentric. As the pipe sections are elevated above the concrete floor he has opportunity to get his fingers beneath the under surface at the joint and make sure that everything is right. The remainder of the circuit of the joint is now filled in with cement by the second man, who follows the pipe layer closely. Any cement which may have gotten inside the pipe is promptly cleared away. The third man puts on a fillet of cement covering the edge of the cement joint, extending the joint cement for ½ or 1 inch. It is claimed for this method of laying pipe that, when the bed has been laid with proper care, the pipe may be set in place very rapidly, little or no packing being required to secure proper grade, also that a small flow of water on the concrete slab will not interfere with the making of the joints. Where pipe is laid directly on the ground or on concrete with depressions to receive the bells so that the pipe rests for its whole length on the bed, there is difficulty in making the joints properly, whether the trench be wet or dry. A water test suggested by Mr. Watson is made next by



VITRIFIED SEWER ON CONCRETE FOUNDATION ON A ND NEAR SALT MARSH, BORO OF BRONX, NEW YORK.

filling the section with water and observing the loss. A slate disk, readily broken out afterwards, is fitted in the lower end and in inlets and a right-angled bend at the upper end, and the water filled in. About a half-hour is then allowed for the escape of air bubbles and 15 minutes additional observation will, ordinarily, now suffice to determine whether the line is tight or not. In Mr. Watson's practice a 9-inch pipe sewer 300 feet long is regarded satisfactory if the water level does not drop more than ½ inch in 10 minutes. This is equivalent to about 11,000 gallons per mile of sewer per 24 hours. Defective joints show moisture if the trench is perfectly dry. If there is water in the trench the dropping of water upon water may be noted by the ear or eye. "In fact, a little water in a trench aids inspection, as it acts like a mirror in reflecting the undersides of the pipes." American practice omits this test, but it is becoming each year more desirable as sewage purification works are installed.

The concrete fill is begun by filling in the spaces between brick supports with fine concrete. Thus a firm support is given the pipe line from end to end. The remainder is then put in place. The side faces may often be battered in towards the sewer so as to finish at the level of the horizontal diameter. In American practice it is common in wet trenches to wrap a strand of jute or oakum which has been soaked in cement grout all around the end of the spigot. A wooden tool may be employed in calking the cement or cement mortar into place. More material is often applied than is needed in order to provide for a fillet finish. Sometimes a second gasket is employed after the jointing space has been partially filled. It is claimed that a joint with a fillet is ordinarily more nearly water-tight than one without. A rather wet mortar will probably make the better joint. To overcome the tendency of such mortar to leave the joint a strip of cheesecloth may be wrapped all round. The joint with a fillet requires much more mortar than one made flush, but is worth its cost in bad soil. The following table by F. C. Coffin, given the amounts of mortar required for joints for vitrified clay pipe:

CUBIC FEET OF MORTAR PER JOINT (STANDARD PIPE).

Diameter of Pipe in Inches.	Flush Joints.	Joint with Fillet.
4	0.0045	0.0113
5	0.0054	0.0134
6	0.0065	0.0195
8	0.0080	0.0315
10	0.0100	0.0393
12	0.0140	0.0479
15	0.0220	0.0640
18	0.0270	0.0877
20	0.0300	0.1443
24	0.0350	0.1700

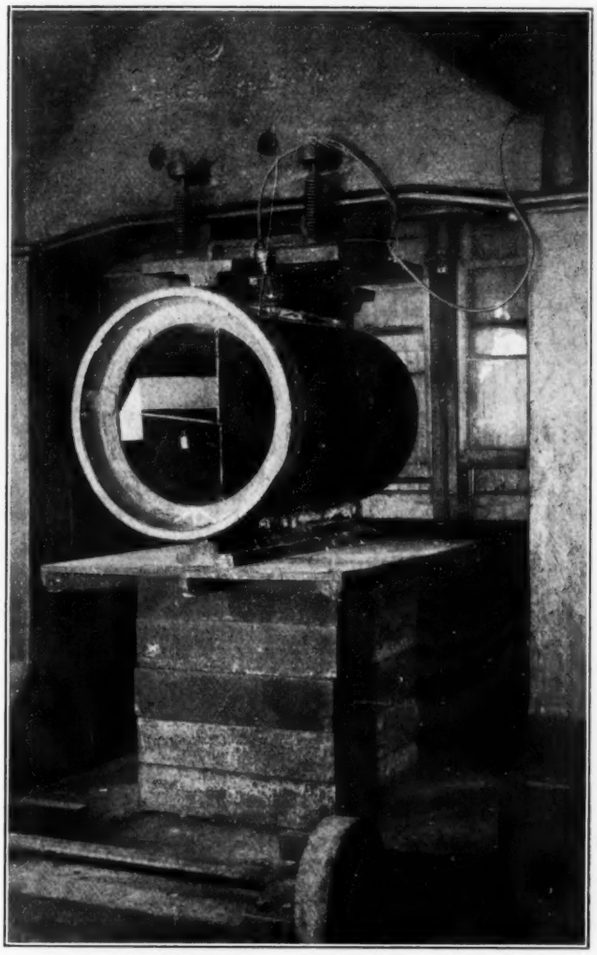
Variations in pipe dimensions will modify these quantities. A Canadian method of jointing pipe requires first that a strip of Russian hemp or like material dipped in neat cement grout be laid in the bottom quarter of the bell at the entrance, and the lower part of the bell be given a coating of stiff cement mortar to line the bell for the lower third, the two insuring the centering of the pipes. The new pipe length is set in place, the spigot being shoved into contact with the shoulder without jamming the hemp piece back into the bell. The joint space above is calked with a suitable gasket just dipped in neat cement grout and the remainder filled with stiff cement mortar. A fillet may be required. Rubber mittens are used in all forming of cement joints. The man calking in the gasket travels two or three joints ahead of the one putting in the cement mortar. A semi-circular wooden scraper is used for cleaning the inside of pipe not larger than 15 inches. If the pipe is 16 to 22 inches in diameter, the joints should be pointed on the lower half of the inside; if larger, the pointing should be carried all round. When a long length of sewer is tested hydraulically the pressure may cause portions of the line to rise. This may be prevented by the use of struts and the like.

Joints are sometimes made by using a mixture of sand and sulphur, a modification of the Stamford joint material, omitting the tar, at one time much used in England. Flour sulphur and sand in equal parts are mixed and heated to 230

degrees, F. The sand should be very fine and contain no grit. It serves two purposes: To prevent shrinkage during the cooling process, and to increase the tensile strength of sulphur from 100 pounds to from 400 to 700 pounds per square inch. If rather coarse sand is employed it will be apt to sink to the bottom of the container. The temperature should not go much beyond 230 degrees, since the mixture then loses fluidity and becomes difficult to pour, regaining it, however, when cooled down. The substance when cold has a high degree of impermeability. The sand is an important factor in its success. A satisfactory sand has an effective size of 0.005 inch, but fine Long Island beach sand was found unsuitable. So experiments with sand proposed for use are recommended to determine whether it is of the right size and quantity to produce a proper cement. The joint is not penetrated by tree roots and is waterproof within one minute after the joints are made. The joint is quite rigid and may give trouble because the material hardens so quickly. Therefore the joint must be poured quickly. A form to fit the pipe and the joint is required and a funnel of clay, says 3 inches high, is advised to give a small head to facilitate the filling process. In cold weather and with large pipe a piece of jute thrown over the pipe close to the joint and lighted will usually provide sufficient heat to prevent cooling too quickly. The cost is somewhat higher than that of ordinary Portland cement joints, but about equal to the cost of the latter if a reasonable effort is made to see that they are really tight.

The use of asphalt for making joints is common in Germany. From Elberfeld come certain points of technique in using this material. The engineer giving the information used an asphalt with specific gravity of 1.32, softening at 131 deg. F. and liquid at 356 deg. At 378 deg. it was sufficiently liquid to pour and reach its place. The light oils in the asphalt are to be retained, consequently the melting container should be kept closed. The surfaces of the pipe within the joint should be made dry and clean before pouring begins. The spigot is set in place in the bell. Then a gasket made of tarred jute, for example, of two strands is calked into the innermost part of the joint space. A rope well smeared with clay is then wrapped round the spigot of the new pipe length and brought up against the bell edge of the old length. Thru a hole made at the top the liquid asphalt is poured. Instead of the rope India rubber may be employed.

P. AND H. TRENCH TAMPER AT WORK COMPACTING A SEWER TRENCH.



TESTING CRUSHING STRENGTH OF VITRIFIED SEWER PIPE, LABORATORY OF BORO OF BROOKLYN, NEW YORK.

A Brooklyn, N. Y., specification for joints demands a material which shall preferably have a bituminous base and shall be quite liquid at 250 deg. F. This temperature is very much lower than that used at Elberfeld. However, the Brooklyn pouring temperature was set at about 400 deg. In pouring a ½-inch space is left to be filled with a guard band of 1:1 cement mortar extending at least 3 inches from the face and outside of the bell.

Another jointing material consists of a mixture of tar and Portland cement. It was extensively used in certain New Jersey sewers where the trenches were quite wet, in preference to cement because cement joints could not be thoroly relied upon to prevent the infiltration of ground water. The mixture was made about as follows: North Carolina tar was poured into a bucket of Portland cement, the mixture being kneaded by hand until a rather stiff dough-like substance was formed. This was rolled on a board into a long rope, which was then calked into the jointing space. A space ½ deep, horizontally, was left, and a cement mortar guard or casing added.

Sometimes the practice is followed, when laying vitrified pipe, of uniting two or even three lengths on the bank. When this can be done without entailing new difficulties, it seems advisable. It is more convenient to make joints on the surface and with pipe lengths vertical. The first length is set up with the spigot end on the ground. The spigot of the next length may then be readily centered in the bell of the bottom length. However, if the bed or floor of the trench is such that the long length formed by the two or three ordinary lengths will not rest properly until considerable settlements and adjustments have taken place, it may be wiser to make all joints in the trench.

One of our illustrations exhibits a 36-inch vitrified, salt glazed, pipe being lowered into a sewer trench in the Boro of Brooklyn. Vitrified pipe of this size is but little used, apparently, in the East, unless the conditions make it especially desirable, as other types of sewer can ordinarily be constructed for less money. The 24-inch size may be regarded as the Brooklyn limit for vitrified pipe where conditions are of an ordinary character. The special object in view in the present case is to get a sewer that will be impervious to leakage in from the outside to keep down the pumping and treatment requirements at sewage disposal points.

The best approved practice with vitrified clay pipe in soft ground provides a concrete cradle. Brooklyn, N. Y., has been using such a cradle and has acquired considerable experience. A wooden platform, upon which the pipe line is blocked up, is used if the bottom of the trench is sand thru which water is moving, otherwise the moving water would destroy the green concrete. Being perpetually submerged the planking will not rot. Where the sand is dry and firm no planking is required, the concrete being placed in immediate contact with the sand. The planks when used may be the ultimate foundation or they may really be part of the capping for a single or double row of wooden piles.

Two of the photographs show sewers in such concrete cradles located in a valley near the Hudson River, half a mile north of the extreme northern end of Manhattan. The land was practically a salt marsh, being only about one foot above mean high water. Wooden piles were put down to considerable depths and cut off at mean high water. The concrete base is supported by them, reaching down one foot below the pile tops and extending up to the level of the sewer grade. The vertical height of the concrete is, accordingly, determined by the two levels.

One photograph shows the sewer in a wide shallow trench and the other where a fill must be made to cover the line. They show the differences in design of the concrete foundation and the manhole supports.

The boro of Brooklyn, New York City, builds a considerable percentage of sewer of vitrified, salt glazed, stoneware pipe. The sizes used run up to 36 inches. Naturally the sewer department needs to determine the degrees in which such pipe possesses certain qualities. The crushing test seeks to determine, for example, the resistance which the pipe when laid may be expected to exert against the load of the back fill. One of the illustrations shows a pipe length in position in the hydraulic press, ready to undergo the crushing test. This press exerts its pressure from above downwards. What is desired is that the pressure and reaction shall be concentrated along a narrow longitudinal path on the crest of the arch and along a similar path beneath the bottom of the invert. Wooden strips are, accordingly, laid lengthwise above and below. However, it is necessary to take special precautions in order to provide for an even bearing. This is done by spreading a thin coat of plaster of paris on the contact surface of the strip. In this way provision is made to develop an evenness of pressure all along the length, in spite of slight irregularities in the pipe surface.

Transforming a Beauty Spot Into a Public Utility

Pleasant Valley, near Salt Lake City, Utah, was admittedly for years one of the beauty spots of the vicinity. People frequented it to admire the scenic effect of the towering mountains cupping the shady valley with its ancient lake in the center. But it was of no utilitarian value until recently the water works department of the city saw its possibilities as a reservoir for augmenting the municipal water supply.

The old lake was simply lined with concrete and thus five million gallons more were placed at the disposal of the water works commission. The cost was $3,744 per million gallons.

(Courtesy of Popular Science Mo.)

King's Highway for Pedestrians

In a recent judgment, Mr. Justice Cross, in dealing with an appeal case in which the Montreal, Que., Tramways Company had been condemned to pay $2,400 damages because of injuries sustained by Francis McAllister, who was struck by a car in Westmount in May, 1913, made some common-sense remarks. In part His Lordship said:

"One cannot but be impressed with the conviction that conditions of present-day city street traffic are quite unduly adding to the perils of the pedestrian. Formerly he had not much to fear but butchers' carts and runaway horses. Now he must look out for tram cars and for silently-running motor vehicles which may come from various directions. Because the great majority of pedestrians, for the sake of bodily safety, run for shelter like hunted animals when they hear the car gong or the motor horn, people are in danger of coming to think that such vehicles have some sort of right of way over foot-passengers.

"That delusion may perhaps be strengthened if it be found that traffic-regulating policemen confine their attention to vehicles as if pedestrians deserved no consideration.

"It should be made clear that such an idea will find no acceptance in a court of law; it should be made clear that the King's highways are for the use of all his subjects and all peaceful wayfarers, and that if there is to be regulation at crossings and busy places it should be in the way of giving the greatest protection to those who need it most."

The judgment of the lower court was upheld.

QUESTION DEPARTMENT

Factors Determining Type of Street Pavement and Method of Assessment

1. What factors would you consider to determine the type of street to be built?
2. What method would you use to assess abutting property according to benefit?
3. What ten cities are the most advanced in street improvements?
4. What books are authority on street construction?
5. Where can I get a list of examination questions such as to call out the qualifications of an efficient highway engineer? B., ———, O.

1. The kind, amount and weight of traffic are the first things to be considered in selecting the type of street to be built. The effect of small quanties of traffic as well as of large quantities should be known and considered. Closely connected with this is the exercise of judgment as to what changes will come in the traffic with the improvement. This is too often overlooked and a pavement for the existing traffic on a road to be improved too often proves woefully insufficient for the traffic developed by the better road or attracted to it from parallel lines, sometimes miles away. The foundation may be such as to require special attention and possibly to modify the choice for the wearing surface, but this does not often happen. The width of the street, actual and in proportion to the traffic, the concentration of traffic on certain lines by tracks, posts, standing vehicles or otherwise, the grade of the street, the ease of drainage, including on flat streets the thoroness and frequency of cleaning, whether traffic is moving or standing still for a considerable portion of the time, especially horse traffic, whether the intersecting streets and driveways are paved or not, are all of them questions of importance. Noisiness is sometimes an important factor. The cost of the pavement is a very important factor, and sometimes first cost has too much effect upon the decision. We do not yet know enough about the relations of the cost of street maintenance and the kind and amount of traffic to be able to design a street most efficiently, so that the street surface we choose will be the cheapest in the long run and the most satisfactory during the life of the pavement, but the older paving engineers have well formed and valuable ideas on this subject, and their advice should be heeded. We are beginning to collect data on this subject and our equipment for intelligent street design is increasing daily.

2. It is generally considered that lots abutting on a street are benefitted in proportion to their frontage on the street. This seems to be true even if the lots vary in depth within the common city limits of such variation. Exceptions are peculiarly shaped lots which have very large or very small frontage on the street in which case the assessment by frontage should be modified. Corner lots are not always benefitted enough by the pavements on the two streets to warrant assessing all the cost of the frontage on both sides. It is customary to reduce the assessment on the long side of the lot, distributing the deducted amount over lots farther from the street by a rapidly decreasing rate per fot. In this case the assessments on the non-abutting lots may well be per square foot of area assessed.

3. It is not easy to select the ten cities most in advance in paving at any particular time, but usually Washington, Buffalo, Rochester, Cleveland, Detroit, Indianapolis are mentioned as among the first and perhaps Boston, Philadelphia, Baltimore and Pittsburg might be added as among the more recent cities doing large amounts of good paving.

4. The standard text-book on street construction are Baker's "Road and Pavements," Tillson's "Street Pavements and Paving Materials," Richardson's "Asphalt Construction," Harger and Bonney's "Highway Engineering Handbook." Two new books are Agg's "Construction of Roads and Pavements" and Folwell's "Practical Street Construction." Still other books are Blanchard's "Highway Engineering," Frost's "Art of Roadmaking," Hubbard's "Dust Preventives and Road Binders," Byrne's "Highway Construction," Whinery's "Specifications for Street Roadway Pavements," etc.

5. Possibly the U. S. Office of Public Roads would be willing to supply a list of questions used in determining qualifications of some grades of its employers. Likewise the highway departments of New York, Massachusetts, Pennsylvania, Illinois, etc.

There have been books published containing such lists of questions, but they are soon out of date.

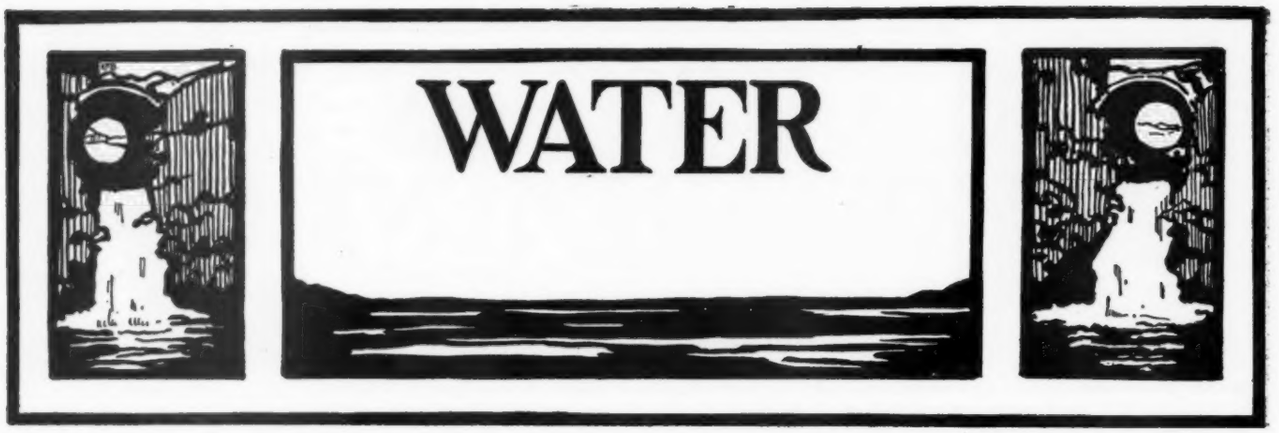
Dealers in Filter Sand

We are in need of filter sand of the Cape May variety, that being the quality of sand we are now using, and I would be pleased if you would give me the address of some concern which handles that sand or the Red Wing, or sand of equal quality. J., Supt. of Water and Lighting Co., ———, Ind.

Following are names of dealers in and producers of filter sand, most of whom can probably furnish sand equal to the specifications mentioned:

Cape May Sand Co., Cape May, N. J.
Red Wing Filter Sand Co., Red Wing, Minn.
Wausau Quartz Co., Wausau, Wis.
Portage Silica Co., Youngstown, O.
Kelley Island Lime and Transportation Co., Cleveland, O.
Hygeia Filter Co., Detroit, Mich.
National Clay Co., Shamrock, Pa.
National Dredging and Lighterage Co., Fidelity Bldg., Philadelphia, Pa.
New York Continental Jewell Filtration Co., New York City.
New England Quartz Co., 107 William St., New York.
H. Steers Sand and Gravel Co., 17 Battery Place, New York.

If our readers can make any additions to this list or corrections in it, we will transmit them to our correspondent.



Excavation of the Baldwin Reservoir, Cleveland, Ohio

The Fred R. Jones Company are at the present time, engaged in the excavation of the Baldwin reservoir for the water department of the city of Cleveland, Ohio.

Excavation work on the reservoir was begun in May, 1915. The total amount of excavation involved is 750,000 cubic yards, of which 230,000 is earth, 350,000 slate and shale and the remainder, approximately 170,000 cubic yards, a mixture of blue sandstone ledge, slate and shale.

This new reservoir is located on a hill about 100 feet higher than the general level of the ground on the east side of Cleveland. Immediately opposite is the old Fairmount reservoir which is to be abandoned, as the new one will take its place. The Baldwin reservoir will have a larger storage capacity of 140,000,000 gallons of water and will have 40 feet greater head than the Fairmount reservoir.

Problems Encountered.

The organization of the work, the laying out of the tracks and the installation of the plant have in many ways been difficult. It was necessary to grade and lay a half mile of track with a maximum grade of 31 per cent. and a maximum curvature of 21 degrees, from a connection with the New York Central railroad thru the streets and the city park property up to the reservoir site. This track was used to move equipment to the site of the reservoir and for the handling of coal and supplies. The reservoir site is on a hillside.

The 70-C shovel was used to make a hillside cut up to the top of the reservoir site, the excavated material being cast over, and to dig an approach cut into the southwest corner of the reservoir. An abandoned quarry located inside the city park limits was utilized as a dumping ground for the material excavated from the reservoir. This quarry when filled, will become valuable land and an unsightly hole will thus be eliminated. At the foot of this grade there is a sharp curve crossing the intersection of two park driveways. A 100-foot ravine which carries the overflow water from Shaker Lakes, a part of the city park system, has to be crossed by means of a wooden trestle. The above presented many preliminary difficulties to the contractor. Furthermore, inasmuch as the reservoir is within a district occupied by wealthy residents and beautiful homes, and as both sides of the basin are lined with buildings, it has been necessary to use extra precaution in blasting in order to avoid as much as possible unnecessary noise and annoyance.

The Basin.

The extreme dimensions of the basin are 1,050 feet by 590 feet. This includes an offset or bench of 7 feet running entirely around the basin. This bench, which is 12 feet in depth, is provided in the earth excavation, as may be seen in the photograph. This wall, or in other words, a slab projecting back on the 7-foot bench, which when refilled, will form a bond against any hydrostatic back pressure when the reservoir is empty.

The First Lift.

The preliminary excavations and also the first cut which was entirely in the earth excavation, was made by the steam shovel. This cut contained mostly earth with some loose slate. The shovel worked double shifts and moved 70,000 cubic yards a month. This output is considered very good when the difficulties which has to be overcome and the heavy grades and curves are taken into consideration.

The Second Lift.

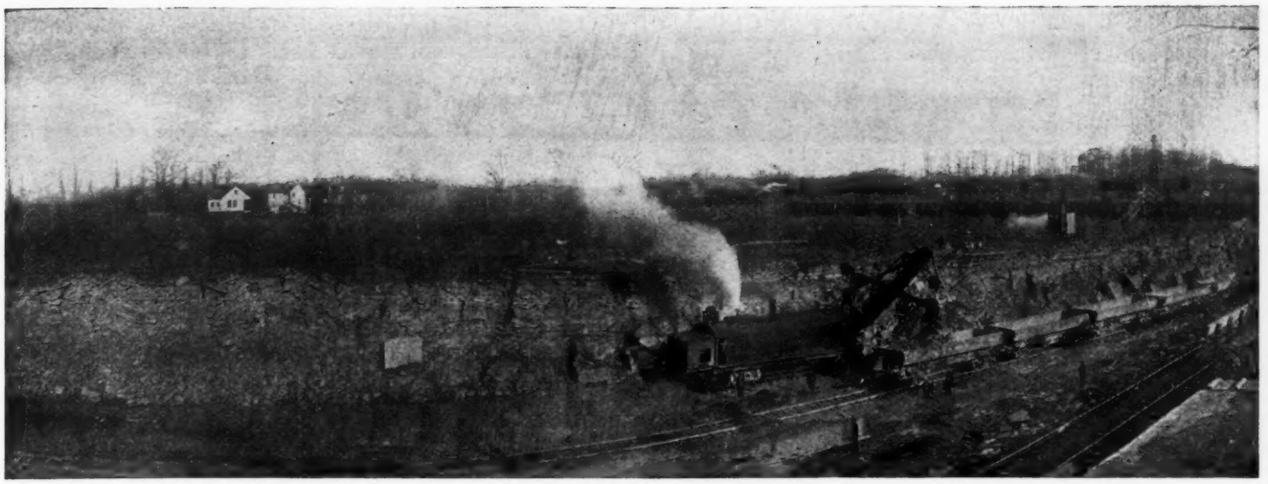
The remainder of the excavation was, as stated above, rock work, and the cut averaged about 25 feet in depth. The method of operation is interesting. The excavation of the basin proper was started by means of a series of inclines. In order to understand the method of procedure, it should be kept in mind that the long way of the basin runs east and west. The first incline was cut along the south wall of the basin in such a manner that the south side of the cut came on the rock neat line, thus completing this portion of the south rock face. The incline was started at the west end at grade and ran up on a scale of 3.05 per cent. grade. This incline or cut connected with the upper or bench track at both the east and west ends, thus completing a run-around. The 7-foot bench, which was taken out on the first cut by the steam shovel, had been widened 2 feet on this first cut in order to allow room for the loading track for the first incline.

When the first incline was completed, a track was then laid here, connecting as stated with the bench on both the east and west ends of the basin. Thus loads could be hauled from the pit at both ends. A new incline was then cut to one side of the first incline. This went in at grade until the loading track on the first incline was 8½ feet above the shovel track. The shovel then cut its way up to the east end of the basin on the same grade as the first incline. This incline in turn served as a loading track and a third incline was cut in a similar manner. This process was continued until the entire length of the pit was opened on grade. The shovel was then backed to the toe of the second incline and all but the first incline was removed, a connection from the bottom of the pit being left with this incline in order to serve as a runway out of the pit.

Now that a good working width was provided at the base of the reservoir, the excavation of the main bank was resumed which, as stated, averages about 25 feet in height.

All inclines were 24 feet wide, but half of this was removed on the next cut, sufficient room being left for the loading track. The grades were all 3.05 per cent.

During the excavation of the pit the dump trains were handled in the usual manner. Regular sized trains were



DIGGING THE SECOND CUT FOR THE BALDWIN RESERVOIR, CLEVELAND, OHIO. (THE FRED R. JONES CO., CONTRACTORS.) 100-C BUCYRS LOUADING 30-YARD WESTERN CARS. NOTE THE CHARACTER OF THE MATERIAL. THE UPPER CUT HAS BEEN COMPLETED. THE 7-FOOT BENCH MAY BE SEEN IN BOTH LOWER CORNERS. THIS BENCH CARRIES THE RUN-AROUND TRACK. CONNECTION WITH THE LOADING TRACK IN THE PIT IS MADE AT BOTH ENDS.

loaded, backed up to the connection with the first incline and then hauled out of the pit.

At the present time the work is being carried on by the 100-C Bucyrus shovel with ten 30-yard cars and four locomotives, an average of 40,000 cubic yards of blasted material being removed per month. Weather conditions, however, have seriously interfered with the work, much time having been lost due to heavy rain and snow storms.

Water is obtained from the city water lines and the locomotives are watered by means of a 6,000-gallon tank with spout attachments.

The drainage of the basin is taken care of by means of a double line of pipe running from a sump, built at the mouth of the approach into the basin, into a city sewer.

Equipment Used.

For the excavation incidental to the construction of this reservoir, the Fred R. Jones Company have used one 70-C Bucyrus shovel, one 100-C Bucyrus shovel, thirty-four 12 and 30-yard air dump cars, four 6-wheel switcher type locomotives, one Cyclone well drill, two Ingersoll-Rand tripod drills, one Ingersoll-Rand turntable wagon drill and two portable boilers. The track is laid with 80-pound rail with standard ties ballasted with cinders.

The Contractor's Camp.

A camp for laborers consisting of three large bunk cars with separate kitchens was provided. These were supplied with city water and garbage disposal service. A first-class repair shop with steam driven machinery is located on the work and equipped with an air compressor, a drill press, a hack saw, a bolt threading and cutting machine, an emery wheel, a 400-pound steam hammer and two power forges. An engine house with washout pit has been built. The contractor's office is a converted standard railroad car. Two large cars are provided for carrying supplies and repair parts.

We are indebted to Messrs. Fred R. Jones and D. B. Hammer, as well as the Bucyrus Company, for the above information.

How to Make Damp Basements Dry or Leaky Cisterns Water-tight

When the necessary precaution has not been taken during construction to damp-proof a basement or to make a cistern water-tight, permanent waterproofing results can be secured by following these simple directions:

If already plastered and it has not adhered to wall in places, which can be determined by striking with a hammer and noting a "dead" sound, remove old plaster. Roughen the surface to be treated by chipping with a cold chisel or similar instrument, and rake brick joints to a depth of ¾-inch, to obtain a bond for the new plaster coat, and clean with a heavy wire or stiff broom to remove all dirt and dust. Clean walls and floor thoroly by scrubbing with a good stiff brush and water, or preferably wash the surface with a solution of 1 part hydrochloric acid to 10 parts water, allowing this to remain about 10 minutes, and then thoroly rinse off the surface with clear water (with a hose under good pressure) to remove the chemical and loose particles resulting from the action of the acid.

To the cleaned saturated surface (or after wetting the surface thoroly) apply a coating of neat cement and water, to which 2 per cent of Medusa waterproofing has been added, mixing to the consistency of thick cream. This grout can be applied with an ordinary brush, but should not be used very far in advance of the plastering, so that the grout paint will not have an opportunity to harden before the plaster is applied.

The plaster coat should consist of one part portland cement, 1½ parts clean sharp sand, and 2 pounds waterproofing powder or paste to 100 pounds cement. The waterproofing powder should be thoroly mixed dry with the dry cement before the addition of sand and water, or the waterproofing paste should be mixed with the water used.

Apply the plastering mortar ½ to ¾-inch thick on the walls and about 2 inches thick over the floor. Special care should be taken to bond the wall and floor coatings, so as to make the waterproofed work continuous over the entire surface.

No more mortar should be mixed than can be used within 30 minutes. It can be applied with a steel trowel, and should be thoroly worked at once with a wood float to make it as as dense as possible. Final finishing may be done with a steel trowel, trowelling for not more than one minute and then leaving undisturbed. Excessive troweling will result in checking.

If there is a continual seepage thru the walls, holes must be bored in the walls and tubes or small gas pipes inserted to concentrate the flow of water and relieve the pressure while the plaster coat is being applied. Calk around pipes with oakum. Drainage pipes should remain open until the waterproofed coat has thoroly set and is capable of resisting the pressure by its own adhesive strength, after which remove

pipes and plug holes with cork or wood and cover with waterproofed cement plaster.

If the water pressure is exceedingly great, it will be necessary to sink sumps on the exterior of the walls to a depth below the basement floor level, and keep pumps going continually until the plaster has thoroly set.

The finished surface must be protected from too rapid drying out, by keeping moist for at least a week to allow it to thoroly harden and to prevent hair-cracks.

Reason for Inadequacy of the New Cambridge, Ohio, Water Supply.

In the course of his work as assistant on the engineer corps of the Pennsylvania railroad system, C. B. Feasey made an investigation of the apparent inadequacy of the newly installed water supply of Cambridge, Ohio, and wrote the following report, which so clearly states the sources of such inadequacy in many small plants that it is printed in full:

The situation is this: a system for supplying the city of Cambridge with chemically pure water has been designed and installed. It is composed (1) of a storage reservoir capable of holding a sixty-day supply of water; (2) a filtration system composed of four 750,000-gallon units, three of which have been installed, and (3) a direct pressure pumping system capable of furnishing a maximum of 3,000,000 gallons of water per day to the mains at the pumping station. The system was installed and pronounced ready for use. The pumps and filters were tested and the water turned into the mains. Almost immediately it was found that the system was apparently inadequate. The question naturally arose as to wherein the system was at fault. Was it in the design? Let us investigate.

The city of Cambridge embraces a population of about 13,000 people. The designer estimated that the total consumption per day would not exceed 1,500,000 gallons, or a per capita rate of 115.4 gallons per twenty-four hours. The experience of other cities would show this figure to be somewhat low. Cleveland's rate is 117 gallons; Cincinnati 130 gallons; Pittsburgh 130 gallons; Philadelphia 227 gallons; Chicago 203 gallons, and Washington, D. C., 192 gallons. A fair average for a town situated and composed as Cambridge is would be 125 gallons per capita per day, or a total daily consumption of 1,625,000 gallons. This represents the actual amount of water furnished by the pumps. There are three factors to be considered in arriving at the efficiency of the system, (1) pump slippage, (2) leakage, and (3) waste.

Pump slippage loses 2 to 3 per cent. of the water supplied at the pumps at the intake gate. In other words, the pump delivers into the mains only 97 per cent. of the water supplied to it per stroke. In the case of the local system this would amount to about 48,750 gallons per day.

Leakage is probably one of the main sources of loss of water in any supply system. In many instances where the pipe lines are fifteen to twenty years old, as they are in Cambridge, the amount of water pumped into the mains at the pump house is three to four times the actual daily consumption. To the layman this would appear excessive, but it is not. Think of the condition that the water lines of this city must be in after carrying for twenty years the chemical laden water of Wills creek. Corrosion is an inadequate term for what must have happened to most of them. Then, too, the pressure formerly was extremely low, and the introduction of the present semi-high pressure is bound to make joints open and cause leakage generally. Even in the case of new pipe an allowance of up to 3,000 gallons per mile is made to cover the leakage. Is it not reasonable then to assume that the leakage in the local system would amount to at least three times the actual consumption, or a total of 975,000 gallons per day? I believe it is.

Last comes the problem of waste. A limited amount of this is inevitable, especially where water has previously been used without regard to the value of it; in this case due to the fact that all the supply formerly amounted to was the pumping of water from Wills creek directly into the mains. Time is the only remedy that can be applied to this sort of waste. An allowance of twenty-five gallons per capita per day is generally conceded to be a reasonable figure for waste and in the local system would amount to 325,000 gallons per day. The summation of the quantities of water used by these three factors is 1,348,750 gallons per day.

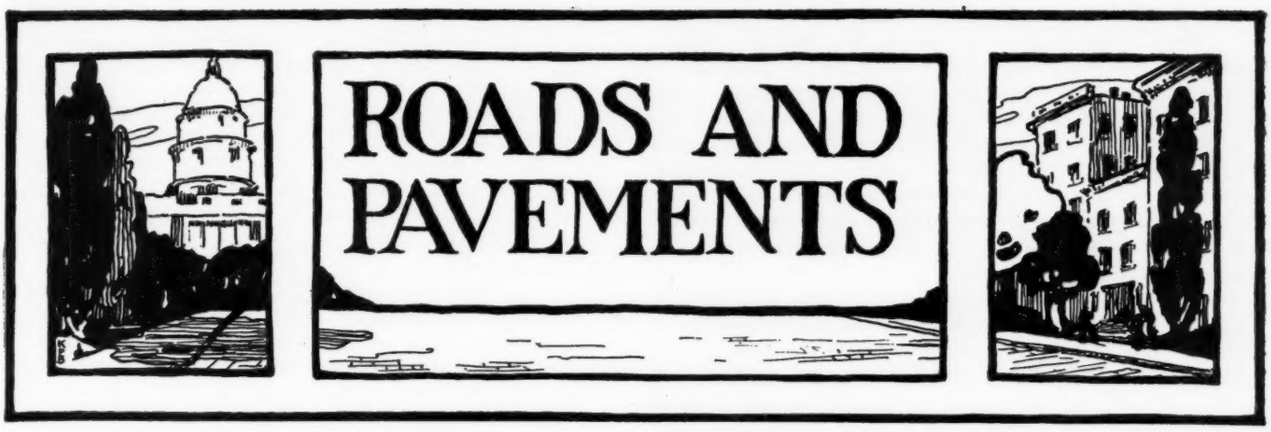
In addition to this we have the amount of water actually used from the supply pipes in the houses. A good figure for this is thirty gallons per capita per day, or a total of 390,000 gallons per day.

These calculations would indicate that the total amount of water which should be furnished to the mains at the pumps should be 1,738,750 gallons per twenty-four hours. This figure is slightly in excess of the figure found by using a per capita daily rate of 125 gallons, but the discrepancy may be attributed to a slight error in one of the per capita rates for loss.

In its present condition, the system is capable of supplying 2,250,000 gallons of water per day, an excess of 521,350 gallons per day over the higher figure calculated. Where then is this excess going? Apparently into leakage and waste. How can it be stopped? The answer is obvious. To dig up all the pipe lines would be both inadvisable and expensive, so that there remains but one thing to do—eliminate the waste and note the result. If this does not render the system adequate, resort to the only remaining action, that of finding and repairing the leaks.

Checking the amount of waste can be economically accomplished in only one way. That is to make a survey of the city embracing every household, and, with the co-operation of the householder, finding and stopping all unnecessary waste. This will require both time and money, but is certainly the first step to be taken. To equip each line with a meter is out of the question because of the high original cost of the meters and the maintenance cost after installation. House meters would cost from fifteen to twenty dollars each and industrial meters from forty to sixty dollars each. This would mean an initial expenditure of around $100,000 for the meters alone, to say nothing of the cost of installing them. A meter system is without doubt the ideal system to have, but cannot be installed all at one time. It would undoubtedly be a good thing to start the installation of a meter system at once, and gradually meter the entire system. But the city of Cambridge cannot wait for the completion of such a system to discover wherein the new water system fails to meet the demand. The sooner then that the water waste survey can be made, the sooner can a course of procedure be outlined. If the stoppage of the unnecessary waste fails to make the supply meet the demand, the addition of the fourth 750,000-gallon unit should be made at once. Then a systematic test of the mains should be carried on. By successively closing the main valves while the pumps are running the amount of leakage in the various lines can be determinerd, and where excessive leakage is discovered the line could be dug up and repaired.

All these suggestions involve the expenditure of more money, but in as much as there are several thousands of dollars already invested in the system, it is economy to use a few hundreds more to put the system in first-class working order.



Gravel Roads for Modern Traffic

It is undoubtedly true that 90 per cent. of the road mileage of a State does not require the highest class of road surfaces and 75 to 80 per cent. require mainly grading and drainage with such surfacing material as may be obtained in the vicinity carefully constructed to shed water and efficiently maintained from day to day. Macadam and gravel are the best surfaces for such lightly traveled roads and a sand-clay surface is very acceptable where nothing better can be obtained. Whether the traffic is all farm traffic, which is accustomed to being held up when the roads are soft in the spring and in rainy seasons or whether it is mixed horse and automobile traffic which wants to get thru at any time, often settles the degree to which a road should be improved.

The township system of road building heretofore in vogue in Indiana has demonstrated beyond question the value of the gravel and macadam forms of road for lightly traveled roads, and if a system of maintenance equal in value to the methods of construction used, crude as they may have been, had been developed it would have been much more difficult than it has been to establish a State Highway Commission to cover the main market roads with harder surfaces. And Indiana is almost the last State to join the ranks of good roads builders.

New Hampshire has been studying this problem under the expert guidance of its State Highway Department and has reached the same conclusions which have developed from the thirty odd years of gravel road building without system and with but little expert supervision anywhere which Indiana has passed thru. Each has shown that the durability of the gravel road under motor truck traffic is greater than that of the macadam road; that the ease of repair is much greater; that the cost of maintenance is much less; that when reasonablly good material is available the cost is less; that the troublesome time with gravel and cheap macadam is when subsoil is soft from rain or outcoming frost; that proper maintenance diminishes the trouble on this account and the time during which the roads should not be traveled in the spring.

New Hampshire has the peculiar condition that the motor traffic on its roads is in the summer when roads are hard and is practically nothing when the roads are soft, and so that State is able to carry the use of gravel roads farther than it can be carried on roads in full use all the year, provided, and they have found this important, that the maintenance of the road with drag and rake and new material and tamper is constant, such as is possible with one man in constant charge of six to ten miles of the road.

The following abstract from a paper by F. H. Colburn, division engineer in the New Hampshire state highway department, shows some of the points demonstrated and the reasons given for the results, corroborating those observed during years of similar construction in Indiana under less scientific conditions and with far less attention to the important subjects of grading, drainage and maintenance. It was given in the short course of highway engineering at the University of Michigan.

The lack of maintenance prior to 1909 had caused the serious deterioration of state aid roads and when the automobile license fund was made available for this purpose the department first directed its attention to repairing those roads which had been built in 1905-06-07-08, and upon which practically no maintenance money had been expended. It was discovered that, although the gravel roads appeared to be in worse condition, they were more easily and cheaply brought back into shape than were the macadam roads. A reshaping and an application of a thin layer of new gravel brought about the desired results, while in the case of the macadam it was practically a case of rebuilding. This led to the adoption of gravel instead of macadam for new construction where that material could be obtained of good quality. It was determined that no matter what the surfacing of the road, drainage, alignment and grade should be taken care of in exactly the same way. If the gravel road proves insufficient to carry the traffic, the old surface, which has been pounded down by heavy traffic, is in a hundred per cent. better condition to receive a surface of bituminous macadam or some other such form of surface than when the road was originally built and the settlement of the foundation of the road has been completed. Therefore a much thinner wearing surface can be put upon this old gravel road than if it had been originally built with no gravel. The traffic has had the use of the gravel road for a number of years, possibly five, and when resurfaced has cost much less than if originally built of the expensive material.

Practically all the foreign automobile traffic comes into the State at its southern extremity and continues nearly to its northern extremity, so that the entire length of the road must be built to accommodate the tourist. Had there been a reasonably good road, rather than the limited mileage of the highest class road, there would certainly have been little or no complaint from the motor vehicle driver. A road maintained so that it is a smooth, easy driving road fully satisfies him. This has been demonstrated by years of Indiana experience so thoroly that it has been difficult to get beyond it on roads so heavily traveled that the maintenance cost is far too high or maintenance in first class condition is impossible.

As to financing road building an assumed example will show the principle on which the decision as to material should be based with the conditions under discussion.

A certain section of modern country road is to be constructed. Some favor a high-class type of pavement, while others favor a gravel road, gravel being plentiful and material for the high-class pavement is within easy hauling distance. The authorities have decided on the issuance of twenty-year bonds at 4½ per cent. A high-class pavement will cost $15,000 per mile. The annual charges for interest on and redemption

of the bonds will amount to a little less than $1,200 per annum, which is our minimum cost per mile per year for our improved road, assuming that the road will not require any maintenance, a condition not yet realized.

The average cost for the construction of 966 miles of gravel road in New Hampshire has been $3,900 per mile. The annual charges for interest on and redemption of bonds in this case would amount to approximately $300.00. Theoretically, therefore, it would be economical to spend nearly $900.00 per mile per year for the maintenance of the gravel road.

In this case it is assumed that the gravel road can be maintained in a condition equal to that of the high-class pavement. The governing factor in this assumption is the traffic. The high-class pavement will withstand practically any traffic expected. During the summer season of 1916 the traffic census sheets show that the New Hampshire East Side Trunk Line carried an average motor vehicle traffic of from 800 to 1,100 cars per day. It is a gravel road for practically its entire length. This road was maintained in an excellent condition at a cost of $260 per mile for the year. Another one of the trunk line highways built of gravel and carrying an average traffic of about 400 vehicles per day was maintained at a cost of $207.25 per mile for the year.

In neither case has a bituminous surface treatment been employed. The application of a bituminous treatment to a gravel road should be delayed as long as possible. When traffic becomes so severe that it is impossible to maintain the gravel road in good condition a non-asphaltic or light asphaltic oil may hold the road under the increased traffic. If, however, the traffic continues to increase and a blanket or mat-forming application of tar or asphalt is found necessary, troubles have begun. When the disintegration of the mat takes place a new surface of a higher type of construction is advisable.

The experience of New Hampshire shows that the patrol system is indispensable for the proper care of gravel roads. There is no day when the patrolman employed upon a gravel road cannot be actively busy on thhe road, and if he is busy each day there will be no time except, possibly, directly after several days' rain, when he is behind in this work.

New Hampshire patrolmen are paid from $3.00 to $3.50 per day and furnish a horse, cart and hoe, shovel and small tools necessary for their work. On 70 per cent. of gravel roads the State furnishes a one-horse split-log drag, and on the 30 per cent. of oiled roads a portable heater with which to do patching. A good patrolman will keep about six miles of gravel road in perfect condition thru the summer, and it is much better to give this man enough road to allow for his steady employment rather than a limited number of days worked per week. Steady employment not only makes road work the man's primary occupation, but also increases his efficiency. One of the pre-requisites of a good patrolman is pride in the section of road he patrols.

No excuse is offered for the construction of gravel roads in New Hampshire. Gravel roads were first built on account of necessity, but as a result of experience the State would adopt such a policy if the work was to be repeated with larger sums of money available.

Labor and Roads

With the coming of spring, contractors are getting their equipment together and making plans to begin early work upon their road construction contracts. Many have their machinery and tools already on the ground, left from uncompleted contracts of last year, and others are purchasing new equipment, either for new work or to change the method of operation for faster and more economical means.

The labor situation has been growing steadily worse on account of the large production of manufactured articles necessitated and demanded of the United States to take the place of the curtailment of similar European industries. Raw products are also demanded in larger quantities to supply the added material for manufacture. These conditions have created a heavier demand on all labor, which, coupled with the practical cessation of immigration and the recalling of many foreigners to their home countries to serve in the army, have combined to seriously deplete the supply of what is ordinarily called unskilled labor.

The economic law of supply and demand has immediately asserted its power in raising wages. This is also aided by the constantly increasing cost of living. From the viewpoint of the road contractor, whose success depends upon the supply and cost of labor more than any other factors, the present conditions are most deplorabl. Where it formerly was possible to have an ample supply at all times and to refuse applicants for jobs every day, the contractor now has to search all sources for men, arrange special convenience, and make extraordinary concessions with regard to pay days to attract labor and to hold men on the job after securing them. As an example of what the contractor must face during the coming season, laborers formerly plentiful and satisfied with $1.75 per day, now are restless and scarce at $2.50 per day, and, moreover, are much less efficient for work requiring a slight amount of skill.

The gravity of the situation has led to the adoption of as much machinery and labor-saving devices as possible, not alone for the saving effected in cost, but in order to be sure that the work will be done on contract time, which might not be the case if he were to remain absolutely dependent upon scarce and restless labor.

A contractor on a piece of road in Pennsylvania last year completed his section of the road on time at less cost by the adoption of labor-savers, while brother contractors on different sections of the same road who depended upon hand labor found the cost very high, were hindered by the labor shortage, and unable to finish their contracts within the time limit.

This contractor used dynamite to blast outfall drainage ditches, a steam shovel in all cuts, using low-strength dynamite to loosen the ground and speed up the action of the shovel and automatic dump wagons to haul out the earth. The other contractors dug many of the ditches by hand, and used pick, plow and hard shovels in digging and loading the earth in cuts.

In many instances the size of the contract or depth of cuts will not permit of the employment of a steam shovel, but in these cases the use of plows and dynamite to loosen the material and of wheeled scrapers for hauling on short-distance work will effect a saving.

The contractor should make a careful study of conditions that he may encounter and lay his plans accordingly. All work possible should be done by labor-saving devices. What may seem a heavy initial expenditure for equipment will very probably prove to be a wise investment before the contract is completed. It is worse than folly to use slow, costly methods.

Bitulithic in Warm Climates

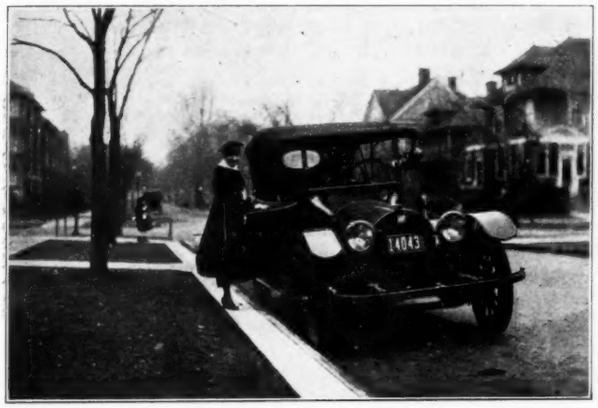
The poularity and success of bitulithic pavement in the states with the warmer climates is shown by the reports from Texas and California. The development of bitulithic in Texas has been quite recent, but 333,652 sq. yds. were laid in 7 Texas cities in 1916, and the total amount of bitulithic in use in Texas cities is 3,337,818 sq. yds. This is almost one-third of its total area of pavements of all kinds of pavements, the total of all being 11,975,002 sq. yds. To the amount of bituluthic may be added 13,291 sq. yds. of Warrenite. The amount of bitulithic and Warrenite is one-third more than of brick,

which is the next most popular pavement, with 2,598,674 sq. yds., including standard and vertical fiber brick pavements.

In California 27 cities have 1,962,518 sq. yds. of bitulithic pavement ranging from 5,000 sq. yds. in Healdsburg to 455,142 sq. yds. in Los Angeles.

Sidewalk Street Curbing

A novelty in the way of curbing has been developed in Chicago to accommodate automobile users. As illustrated in the accompanying view, which was taken on Fargo avenue, Chicago, the curb has been widened so that it makes a really



usable sidewalk, thus avoiding a walk thru mud or damp grass when autoists enter or leave an automobile that has stopped at a point not directly in front of the cross walk leading from the residence to the curbing.

Comparative Tests of Bricks of Various Materials

A standard test of the comparative qualities of vitrified paving bricks is that in the rattler, giving the percentage of loss by the abrasion occurring by the rubbing of the bricks and the round steel shot used with the bricks as the rattler revolves for a certain number of revolutions.

While this abrasion test is of considerable value in comwith each other, its value in comparing bricks of different materials is not yet demonstrated.

The Standard Brick Company of Crawfordsville, Ind., has paring bricks of the same material, vitrified clay or shale, added something to our stock of information on the subject by making some concrete bricks of the same size as vitrified bricks and subjecting them to the same tests.

Bricks made of the ordinary proportions for construction of concrete roads—1 part cement, 2 parts sand and 3 parts gravel—lost 80 per cent. in 1,000 revolutions of the rattler, ten bricks being run, with the standard 300 pounds of steel balls of two sizes, at the rate of 30 revolutions a minute.

Bricks made with 1 part cement and 1 part sand lost 75.4 per cent. in the full time test of 1,800 revolutions.

Five of the 1:1 cement mortar bricks run with 5 vitrified bricks and the shot showed loss of 15.2 per cent. of the vitrified brick and 70.8 per cent. of the cement brick.

Ten vitrified brick run with the shot lost 15.72 per cent. in 1,800 revolutions.

While these results are interesting, they are not conclusive for several very good reasons, and the difference in value of the two materials for paving purposes is by no means as great as the differences in proportions of loss in the rattler test hight indicate.

Relative Values in Public Health Work

Not how many dollars to spend but how to spend the dollars you have for public health activities is the subject of a recently issued pamphlet on "Relative Values in Public Health Work." The author is Franz Schneider, Jr., sanitarian of the Department of Surveys and Exhibits, Russell Sage Foundation, who has conducted public health surveys of Newark, Springfield, Ill., Topeka, Atlanta, and other cities.

Given some 1,400,000 deaths annually in continental United States, of which one in four or even one in three are from preventable causes, the problem of the public health officer is to so spend the city's health funds as to prevent these losses so far as is possible. The health officials "must decide what parts of the losses are preventable, and must determine how the greatest return in prevention can be obtained with the money available. This is the problem of relative values in public health work."

The discussion cannot well be condensed from the already concise presentation in this ten-page pamphlet. It is offered as a basis for the discussion of health budgets by officials and citizens who seek the highest returns on the city's investment in terms of deaths prevented. Among the tests applied are the damage done by the preventable diseases, their preventability, cost of prevention, and communicability—small pox, for example, "must be suppressed immediately upon appearance, almost without regard to cost."

Good Roads Notes

Governor Goodrich of Indiana has appointed the four members of the new State Highway Commission as follows: Lorenzo H. Wright, Indianapolis, master of Indiana State Grange; David C. Jenkins, Kokomo, manufacturer; Haines Egbert, Goshen, lumber; S. W. (or Lewis) Taylor, Boonville, farmer.

In 1910 California voters approved an $18,000,000 road bond issue, with which was constructed a large mileage of concrete roads. The newly constructed roads proved so satisfactory that at the close of 1916 the State approved a new $15,000,000 bond issue by vote of almost 4 to 1. In 1910 Los Angeles county voters were almost 4 to 1 against the proposition, but in 1916 they turned the tables and approved the new issue by a vote of more than 3 to 1. Not a single county voted against the proposition in 1916.

W. F. Childs of the Maryland road building force told a meeting of Virginia road builders that specifications must cover completely and in detail each item in the construction of a concrete road. They should be explicit, not ambiguous; specific, not optional; they should be clear and easy of interpretation, and should not contain clauses of which the meaning is liable to be misconstrued. Inspection is most essential. One inspector should be made chief to avoid conflict of authority and needless antagonism of contractors. If more than one mixer is employed it will be necessary to have an inspector for each mixer as well as for the grading and drainage. If the contractor handles the work so as to complete the grading and drainage before laying the concrete, the inspector on the grading can be employed on the concreting later. The inspector at the mixer looks after the final shaping of the roadbed, the preparation of the sub-grade and setting the forms, as well as mixing and placing the concrete. He must see that the sub-grade is uniformly consolidated, the side forms are clean and true to line and grade, the materials for the concrete are suitable and properly proportioned, the mixing is done thoroly and the concrete placed and finished properly, and that finally the concrete is kept damp and protected from injury until it is cured to a condition that will permit traffic over it without injuring it.

Bitulithic Pavements Laid in 1916 and Proposed for 1917

Descriptions of Pavements as laid, cost per square yard and total cost. Warrenite included.

Design, Cost and Quantity are shown.

State and City	Sq. yds. laid 1916	Base		Wearing Surface		Cost per sq. yd. pave. and foundation	Total cost of pave., inc. (1) (2) (3) (4)	Kind of asphalt	Proposed yardage in 1917
		Thick	Propor.	Thick	Propor.				
Arizona—									
Ajo	18,705	...	.....	...	....	.....	.....	.....	.....
Douglas	28,000	5	1:3:6	2	....	$2.35 (1)	.....	Warren A. C.	30,000
Flagstaff	11,261	...	.....	...	....	.....	.....	.....	.....
Phoenix	56,646	...	.....	...	....	2.12[26]	133,714	.....	.....
Tucson	67,219	5	1:3:6	...	....	2.155	122,620	California	45,000
Arkansas—									
Hot Springs	4,000	5	1:2:5	2	....	2.00	14,000	Bermudez	.....
Little Rock	21,324	...	.....	...	....	.....	.....	.....	.....
California—									
Berkeley	23,900	6	1:3:6	2	....	1.40	40,700	Warrenite	.....
Brawley	9,636	...	.....	...	....	.....	.....	.....	.....
Fresno	19,828	...	.....	...	....	.....	.....	.....	.....
Long Beach	5,094	4	.....	1½	....	1.42	.....	.....	.....
Los Angeles	104,672	4-6	1:3:6	2½	....	1.58	165,382	.....	.....
Richmond	95,682	5	1:2:4	2	....	2.16	508,000	California	10,000
San Luis Obispo	.....	4	1:2½:5	¾	O & S	1.08	.....	90% Asphalt	10,000
San Pedro	52,007	...	.....	...	....	.....	.....	.....	.....
Santa Monica	15,870	5	1:3:6	2	....	1.395	28,991	California	.....
Whittier	8,802	...	.....	...	....	.....	.....	.....	.....
Wilmington	5,764	...	.....	...	....	.....	.....	.....	.....
Colorado—									
Denver	25,000	...	.....	...	....	.....	.....	.....	.....
Pueblo	40,403	...	.....	...	....	.....	.....	.....	.....
Connecticut—									
Bristol	2,000	5	1:3:5	2	....	.....	4,000	Amiesite	.....
Danbury	8,000	...[41]	.....	2	....	1.05	.....[51]	Amiesite	.....
New Canaan	8,800	...	.....	...	....	.....	.....	.....	.....
Stamford	4,624	...	.....	...	....	.....	.....	.....	.....
Winchester	11,743	...	.....	...	....	.....	.....	.....	.....
Winsted	9,801	6	Stone	2	....	1.35	16,000	Warrenite	6,000
Georgia—									
Atlanta	12,802	6	1:3:6	2	....	.....	28,804	.....	.....
Idaho—									
Blackfoot	47,091	...	.....	...	....	.....	.....	.....	.....
Boise	48,394	3	[11] G	2	[11] G	1.64	106,972	California	.....
Coeur d'Alene	.....	...	.....	...	....	.....	.....	.....	8,000
Idaho Falls	47,947	...	.....	...	....	.....	.....	.....	.....
Pocatello	.....	...	.....	...	....	.....	.....	.....	20,570
Iowa—									
Ames	11,800	...	.....	...	....	.....	.....	.....	.....
Creston	47,431	4	1:3:5	2	....	1.89	92,690	Berm. & Tex.	.....
Des Moines	82,707	...	.....	...	....	.....	.....	.....	.....
Grinnell	114,000	...	.....	...	....	.....	.....	.....	.....
Jefferson	45,300	...	.....	...	....	.....	.....	.....	.....
Knoxville	13,660	5	1:3:5	2	65% Asph.	1.98 (1)	36,191	Berm. & Flux	.....
Mt. Pleasant	27,600	5	1:3:5	2	65% Asph.	1.89	72,877	Bermudez	.....
Muscatine	25,615	5	1:6G	2	....	1.83	55,091	Bermudez	0
Perry	30,000	...	.....	...	....	.....	.....	.....	.....
Kansas—									
Kansas City	30,216	...	.....	...	....	.....	.....	.....	.....
Rosedale	.....	...	.....	...	....	.....	.....	.....	30,000
Kentucky—									
Owensboro	.....	...	.....	...	....	.....	.....	.....	25,000[9]
Louisiana—									
New Orleans	188,656	...	.....	...	....	.....	.....	.....	.....
Maine—									
Lewiston	5,000	...	.....	...	....	.....	.....	.....	.....
Massachusetts—									
Boston	4,640	...	.....	...	....	.....	.....	.....	.....
Cambridge	10,310	...[41]	.....	2	....	.....	2.75	.....	.....
Dedham	3,568	...	.....	...	....	.....	.....	.....	.....
Fall River	57,895	...	.....	...	....	.....	.....	.....	.....
Michigan—									
Sault Ste Marie	4,836	...	1:2½:5	2	....	2.40	14,504	Warren	.....
Minnesota—									
Buhl	12,211	...	.....	...	....	.....	.....	.....	.....
Duluth	21,507	...	.....	...	....	.....	.....	.....	.....
Eveleth	20,004	6	1:4	2	....	2.50	55,000 (1)	.....	25,000[9]
Fairmont	14,734	...	.....	...	....	.....	.....	.....	.....
Gilbert	26,700	...	.....	...	....	.....	.....	.....	.....
Hibbing	4,687	5	1:3:5	...	....	2 68	18,422	.....	40,000
St. Cloud	4,626	5	1:3:5	2	....	2.15	10,500 (1) (3)	Bermudez	25,000
Virginia	1,864	6	1:2:4	2	....	2.44	47,606	.....	2,000
Missouri—									
Hannibal	6,000	...	.....	...	....	.....	.....	.....	.....
Joplin	15,411	...	.....	...	....	.....	.....	.....	.....
St. Louis	6,325	...	.....	...	....	1.98	20,000 (1) (2)	.....	40,000

State and City	Sq. yds. laid 1916	Base: Thick	Base: Propor.	Wearing Surface: Thick	Wearing Surface: Propor.	Cost per sq. yd. pave. and foundation	Total cost of pave., inc. (1) (2) (3) (4)	Kind of asphalt	Proposed yardage in 1917
Montana—									
Billings	35,893	4	1:3:6	1½	....	1.91	99,439	California	.....
Bozeman	34,794	...	.....	...	....	.....	.....	.....	.....
Butte	22,586	4	1:3:5	2	....	2.55(1)	79,377	.....	27,000
Ft. Benton	11,609	...	.....	...	....	.....	.....	.....	.....
Great Falls	18,830	4	1:3:5	2	....	1.90	43,432	Warren	.....
Lewiston	12,232	...	.....	...	....	.....	.....	.....	.....
Livingston	5,379	4	.....	1½	....	2.06	14,396	California	.....
Missoula	17,278	...	.....	...	....	.....	.....	.....	.....
New Hampshire—									
Franklin	2,676	...	.....	...	....	.....	.....	.....	.....
New Jersey—									
Belleville	9,026	...	.....	...	....	.....	.....	.....	.....
Bloomfield	8,707	...	.....	...	....	.....	.....	.....	.....
Harrison	18,512	6	1:3:6	2½	....	2.29(1)	.....	.....	20,000
Irvington	7,472	6	1:3:6	2	....	2.40	21,997	Trinidad	11,270
Kearny	11,031	...	.....	...	....	.....	.....	.....	.....
Neptune City	10,729	...	.....	...	....	.....	.....	.....	.....
New Brunswick	89,319	5	1:3:6	2	....	2.65	2.80	Warrenite	.....[9]
South Amboy	.....	...	.....	...	....	.....	.....	Warrenite	20,000
Summit	4,340	...	.....	...	....	1.70	.....	Amiesite	.....
New Mexico—									
Las Vegas	6,342	...	.....	...	....	.....	.....	.....	.....
New York—									
Binghamton	8,147	6	1:3:6	2	....	2.30	23,435	.....	.....
Elmira	10,644	5	1:2½:5	2	....	2.25	29,171	Warren	.....
Endicott	23,163	...	.....	...	....	.....	.....	.....	.....
Gloversville	13,657	...	.....	...	....	.....	.....	.....	.....
Hempstead	9,276	...	.....	...	....	.....	.....	.....	.....
Herkimer	8,680	4	1:3:6	2	....	2.18	.....	Bermudez	8,000
Johnson City	4,692	...	.....	...	....	.....	.....	.....	.....
Little Falls	9,265	5	1:2½:5	2	....	2.35	2.85	.....	.....
New Rochelle	17,132	6	1:3:6	2	....	1.50	53,615	W. B .California	.....
New Rochelle	19,297	...	.....	2	....	1.29	24,893	Amiesite	.....
Oneida	4,874	...	.....	...	....	.....	.....	.....	.....
Rome	25,332	...	.....	...	....	.....	.....	.....	.....
Salamonica	12,215	...[27]	.....	2½	....	1.65	2.10	Amiesite	15,000
Utica	38,256	...	.....	...	....	.....	.....	.....	.....
Yonkers	41,176	...	.....	...	....	.....	.....	.....	.....
North Carolina—									
Albermarle	20,296	...	.....	...	....	.....	.....	.....	.....
Greensboro	18,790	...	.....	...	....	.....	.....	.....	.....
Raleigh	80,000	4	1:3:6	2	....	1.52	1.70	Warrenite	100,000
Weldon	10,000	...	.....	...	....	.....	.....	.....	.....
Wilson	40,000	...	.....	...	....	.....	.....	.....	.....
Winston-Salem	6,022	...	.....	...	....	.....	.....	.....	.....
North Dakota—									
Mismarck	25,000	5	1:2:4	2	....	2.38	68,000	Bermudez	20,000
Fargo	35,712	5	1:6	2	....	2.136	109,907	.....	100,268[9]
Mandan	51,088	5	1:2½:5	2	....	2.28-2.43	180,181	.....	.....
Minot	24,634	...	.....	...	....	.....	.....	.....	.....
Ohio—									
Bixley	12,740	...	.....	...	....	.....	.....	.....	.....
Bowling Green	.....	...	.....	...	....	.....	.....	.....	2,225
Cincinnati	10,914	6	1:3:6	2	....[23]	2.57	27,768	.....	.....
Cleveland	6,749	...	.....	2	....	2.22	.....	.....	.....
Lakewood	4,112	6	1:3:6	2	....	2.20	10,072	Bermudez	.....
Piqua	21,000	5	.....	...	....	1.88	60,000	Bermudez	.....
Youngstown	15,617	2	.....	2	....	2.70	35,796	Trinidad	.....
Oregon—									
Astoria	46,140	4-5	1:3:5	1½-2½	....[29]	.....	.....	.....	45,000[9]
Portland	95,227	4[27]	.....	2	....	1.37	173,459	California	56,169
Portland	10,361	Redressing		3½	....	1.04	12,170	California	6,000
Portland	7,556	On old concrete		2	....	1.10	9,878	California	.....
Portland	2,566	3	.....	2	G	1.30	4,436	California	7,618
Pennsylvania—									
Allentown	4,110	Old telford		2	....	1.30	.....	Amiesite	5,500
Altoona	2,929	...	.....	...	....	.....	.....	.....	.....
Bethlehem	37,738	4 & 5	1:2½:5	2½	½	1.75[45]	74,154	Amiesite	.....
Hazleton	5,176	...[27]	.....	...	....	1.04	7,601	Tex.-Amies.	.....
Lebanon	10,000	1:3:6	.....	2	....	1.95	2.10	.....	15,000
Rhode Island—									
Pawtucket	21,269	...	.....	...	....	.....	.....	Warrenite	.....
Providence	20,552	6	1:3:6	2	....	.....	2.10	.....	.....
Woonsocket	7,900	5	.....	2	....	.....	2.35(1)	.....	.....
South Carolina—									
Sumter	10,581	...	.....	...	....	.....	.....	.....	.....
South Dakota—									
Sioux Falls	42,734	6	1:2½:5	2	....	2.10	2.26(1)	California	50,000[9]
Tennessee—									
Nashville	55,342	...	.....	...	....	.....	.....	.....	.....
Texas—									
Austin	58,932	5	1:7g	...	....	2.00	2.068	War.-Tex.	50,000
Corpus Christi	48,892	...	.....	...	....	.....	.....	Texaco	.....
Dallas	32,309	5	1:8	2	....	.....	82,655	Texaco	267,164
El Paso	131,608	...	.....	...	....	.....	.....	Texaco	.....
Ft. Worth	36,718	...	.....	2	....	2.088	.....	Tex.-Cal.	.....
Paris	24,110	5	1:8	2	....	.....	2.30(1)	.....	.....
San Antonio	11,880	5	1:3:6	2	....	2.30	2.50	California	60,000[9]
Utah—									
Salt Lake City	34,950	...	.....	2	....	1.80-2.00	106,100	California	35,000
Washington—									
Kent	22,229	...	.....	...	....	.....	.....	.....	.....
Vancouver	2,650	...	.....[27]	2	....	1.52	4,228	.....	.....
Walla Walla	19,676	2½	.....	1½	....	1.29	39,249	Gravel Bit.	.....
Wyoming—									
Caspar	17,000	...	.....	...	....	.....	.....	.....	.....
Sheridan	4,941	5	1:3:5	2	....	2.12	18,000	.....	5,820

MISCELLANEOUS

Meetings of Organizations

May 7-9, at Kansas City, Mo., National Conference on City Planning.

May 7-11, at Richmond, Va., American Water Works Association. John M. Divin secretary, Troy, N. Y. The city planning committee, E. P. Goodrich, chairman, 35 Nassau street, New York, will have an exhibit of photographs, drawings, etc., particularly of water-works structures, to which it desires contributions.

May 8, in United Engineering Societies' building, New York. Annual meeting of the Society for Electrical Development. J. M. Wakeman, general manager.

May 8-9, at St. Louis, Mo. Institute of Paving Brick Manufacturers. H. H. Macdonald, secretary, 830 B. of L. E. Bldg., Cleveland, Ohio.

May 8-10, at Washington, D. C. National Fire Protection Association. Franklin H. Wentworth, secretary, 87 Milk street, Boston, Mass.

May 22-25, at Chicago, Ill. Western Efficiency Society; subject of conference, "The Human Factor in Industrial Preparedness," under a number of sub-titles.

May 23-24, at Saginaw, Mich. Michigan State Good Roads Association. A. A. Anderson, secretary, Hastings, Mich.

May 23-25, at Auditorium Hotel, Chicago, Ill. The Western Efficiency Society, discussing the human factor in administration. Municipalities are expected to take much interest in this meeting and to be represented in the discussions.

June 11, at Buffalo, N. Y. New York State Conference of Mayors and Other City Officials. W. P. Capes, secretary, 25 Washington avenue, Albany, N. Y.

June 26-30, at Hotel Traymore, Atlantic City, N. J. American Society for Testing Materials. Edgar Marburg, secretary, Philadelphia, Pa.

Sept. 11-14, at Hartford, Conn. The New England Water Works Association. Willard Kent, secretary, Narragansett Pier, R. I.

November 12-16, at Hotel Gruenewald, New Orleans, La. American Society of Municipal Improvements. Charles C. Brown, secretary, 702 Wulsin building, Indianapolis, Ind.

Civil Service Examinations

The United States navy needs ship draftsmen and cannot find enough of them. Applicants will be rated on physical ability and education, training, experience and ability, without the ordinary technical examination. Grade 1, $3.28 to $4 a day; 2, $4 to $5.04; 3, $5.04 to $6; 4, over $6 a day. Ask for form of application 1312 at the usual places.

Also architectural draftsmen in Bureau of Yards and Docks, Navy Department. Grade 1, $3.04 to $3.84; 2, $4 to $$5.04; 3, $5.28 to $6; 4, $6.24 to $8 a day.

Also assistant inspector of engineering material, air craft, $4.48 to $5.04 a day.

Also sub-inspector of construction in Navy Department at $3.28 to $5.52 a day.

Also mechanical draftsman in office of Chief of Ordinance, War Department, at $1,000 to $1,400 a year.

Also assistant inspector of wooden hull construction at $4 to $6 a day.

Also mechanical engineers at Frankford Arsenal, Philadelphia, Pa., as follows: Artillery ammunition at $3,000 to $3.600; experimental work at $2,500 to $3,000; optical instruments, etc., at $2,200 to $2,600 a year.

Also draftsman assistant to chief draftsman at Watertown Arsenal, Watertown, Mass., at $2,200 a year.

May 8—Metallurgical engineer in Bureau of Steam engineering, Navy Department, Washington, D. C., at $7.04 a day. Also mechanical draftsman in Bureau of Yards and Docks, Navy Department. Grade 1, $3.52 to $4 a day; 2, $4 to $5.04; 3, $5.04 to $6 a day.

May 15—Radio draftsman in Navy Department, Washington, D. C., at $3.04 to $6 a day.

May 16—Electrical assistant, signal service at large, War Department, at $1,200 a year.

Municipal Reports

Report of the Board of Public Works of Little Falls, N. Y., for 1916. George I. Oakley, city engineer and executive officer.

Report of the St. Louis, Mo., City Plan Commission on a boulevard on Kingshighway. Harland Bartholomew, engineer.

Technical Schools

The University of Wisconsin has issued its preliminary announcement of courses of study in its summer session, June 25 to August 3, at Madison. The College of Engineering offers a number of courses in electrical, chemical, hydraulic, topographical and mechanical engineering.

The formal opening of the new chemical laboratory of the University of Cincinnati, Ohio, took place April 7 with addresses by Emil Pollard, Dr. Lander W. Jones, Dr. John Uri Lloyd and Dr. Charles E. Herty.

The bulletin of New York University for April 3 gives the preliminary announcement of the courses of study in the School of Commerce, Accounts and Finance for 1917-18.

Personal Notes

Gen. George W. Goethals has accepted the position of state engineer of New Jersey, created by an act of the Legislature, passed recently with the co-operation of Governor Edge. The state engineer will have charge not only of the $15,000,000 road system proposed, but of the engineering work of the present or future commissions on tunnels or bridges under or over the Hudson or Delaware rivers, canals, water front developments, etc.

A. R. Taylor has been appointed State Highway Commissioner of Ohio at Columbus.

Christopher Harrison has been appointed as city engineer of Montclair, N. J., going from a like position at Everett, Mass.

Walter Braun, Franklin county engineer, and Joseph H. Fleming and E. P. Knollman of his office have formed the engineering and surveying firm of Braun, Fleming & Knollman of Columbus, Ohio.

H. Peyton Mobberly, recently division engineer of the T. & P. railway, has entered the general practice of engineering at Springfield, Mo.

Alexander W. Graham has been appointed chief engineer of the Missouri State Highway Commission at Jefferson City.

C. M. Dulaney, Bristol, Tenn., is engineer of the Johnson County Pike Commission of Mountain City, Tenn.

O. H. Buckman is the new city engineer of Napa, Cal.

O. J. DeSpain is city engineer of Ritzville, Wash. He is also county engineer of Adams county.

Prof. J. G. Scrugham of Nevada State University has been appointed state engineer.

O. A. Rickers has been appointed city engineer of Huron, S. D.

Chicago Paving Inspectors and Contractors Vindicated

The special trial board appointed by the Chicago Civil Service Commission to try the case against the city paving inspectors accused of incompetency, inefficiency, neglect of duty and making false reports has dismissed the charges. They base their action, as foreshadowed by MUNICIPAL ENGINEERING, on the evidence that Professor Baker made his report, on which the charges were based, from data furnished him by others, in which only notes from field books finding fault with contractors' work were included, and from erroneous information furnished him regarding the general condition of all paving done during 1916. A motive for such action is suggested, and the evidence referred to is rejected as generally untrustworthy. This action is justified by the evidence of the engineers of the Chicago Association of Commerce, who made almost daily inspection of streets under construction, to the effect that the 1916 work was done according to plans and specifications, and that paving inspectors always aided them in correcting any irregularities found.

Records of Official Surveys

The records devised by H. A. Mark, county surveyor of Garden county, Nebraska, will give many suggestions as to the keeping and indexing of records of surveys, which will be of value for many others than official surveyors, tho some of the forms of record are prepared to comply as nearly as possible with the laws of Nebraska. The following description of the system is taken from a paper on the subject by Mr. Mark before the Nebraska Engineering Society.

The Official Record.

For the official record, I decided upon a loose-leaf book. To make the book suitable for retracement work as well as the subdivision of a section, as contemplated in the statutes, I found it only necessary to have two different plats.

I had a quantity of loose-leaf pages prepared as follows: First, a leaf with both pages blank except for caption and marginal ruling. Second, a leaf identical with the first, excepting the addition of a marginal column with the word "Chains" printed at its top. Third, a leaf with its first page as described for the second leaf and its second page ruled and lettered for recording latitudes, departures and closing errors. Fourth, a leaf with the first page containing a sectional one-inch-to-the-mile plat, 10 by 10 inches in size, being a township bounded with two rows of sections of each of the contiguous townships.

Below the plat is printed the legend of the different corner signs. The lines of the map are in tint, and the lines of the survey and the corner signs are to be inserted in black. The balance of the page is filled with a blank form for the recording of the final oaths of assistants. The second page of this leaf repeats the blanks for final oaths, and concludes with the surveyor's certificate. This printing required five different forms for the four leaves, and to complete the book for subdivision work one more leaf carying the plat of a section eight inches to the mile should be added. But as I have not as yet, in three years of constant work, had the opportunity of subdividing a section where retracement of, and establishment of, exterior corners was not needed, I have not felt the need of the plat. In compiling the record of a survey, I use as many of these different pages as the nature of the work requires.

The Field Memorandum.

Careful research failed to discover a field memorandum book on sale arranged for recording field memoranda as I believed they should be kept. The best I have been able to find for the work is an ordinary blank book, Demy 8va, 4¾ by ½ inches in size, semi-flexible morocco covers, containing 176 pages, put out by McClurg, of Chicago.

I use a separate field memorandum book for each township, designating them by number. The townships of Garden county number from 15 to 23 north and the ranges from 41 to 46 west. The volumes of each township are numbered from one up, consecutively. This number is followed by a dash and the unit digit of the township number, another dash and the unit digit of the number of the range. The dash is used to more easily distinguish the volume numbers from page and other figures appearing in the index without using the distinguishing prefixes. Of course, this number system could not be used in a county where the digit of the town and range number repeat.

The Index.

Realizing that any records not well indexed would be of little value, and as the statutes require indexing of both the memorandum and record, I attempted an index system that would be both simple, comprehensive and efficient, and one that would not become cumbersome as records should accumulate.

After study and experiment with different systems, I decided that for the official record index an outline map would be best. The scale of the index map I use is ⅜-in. to the mile, this being the size that will admit the area between two standard lines being placed on one page. It requires three pages for one index map of the county. The maps are in tint, with the township and range marked in tint, and the section numbers in a different tint. The page figures are inserted in black at or near the point on the map described in the record. Such an index would not class as a work of art, but it is convenient. I use three of these index maps. One for retracement and subdivision surveys, one for road surveys, and the third for miscellaneous surveys. By using different colored page figures the same map will index several volumes. In this I do not think I produced anything new, but combined the ideas of several I had seen.

Field Memorandum Index.

Since in my field memorandum I write a daily record of the survey, to devise a suitable and comprehensive index that would be both simple and efficient became a puzzling problem. After making several extended retracement surveys, some of them requiring memoranda filling more than one volume, I made a careful study and analysis of the matter recorded,

and found that when a section had been completely retracted, matter had been entered concerning each of its four sides, each of its four section corners, and each of its four quarter section corners on the exterior. Beginning at the northeast corner of the section, and bounding it counter-clockwise, I found twelve general subdivisions necessary for classifying the information. I, therefore, set aside the first thirty-six pages of each field memorandum book for the index of the thirty-six sections of the township, respectively, and the thirty-seventh page for the indexing of matter that could not be grouped under the twelve subdivisions. Later, to index subdivision work, I found it necessary to add a thirteenth division.

Index Abbreviations.

I divide each page into the respective thirteen divisions and mark with abbreviations as follows:

"NE," meaning section corner at the northeast corner of the section;

"N¼," quarter-section corner on the north side of the section;

"NL," line, or boundary, on the north side of the section;

"NW," section corner at the northwest corner of the section;

"W¼," quarter-section corner on the west side of the section;

"WL," line, or boundary, on the west side of the section;

"SW," section corner at the southwest corner of the section;

"S¼," quarter-section corner on the south side of the section;

"SL," line, or boundary, on the south side of the section;

"SE," section corner at the southeast corner of the section;

"E¼," quarter-section corner on the east side of the section;

"EL," line, or boundary, on the east side of the section;

"INT," work within the section, or subdivision.

By this system, when cross-indexed, the matter pertaining to each line and exterior quarter-section corner appears on two different pages, and of each section corner on four pages. If a town or range line or corner, it appears in two volumes, and if a township corner, in the volumes of four different townships.

Should a survey, the purpose of which is to establish a line or corner in a particular township, extend into an adjoining township or on a town or range line between other townships, the record is all made in the volume pertaining to the purpose of the survey, but those parts affecting the other townships will be indexed in the volumes devoted to those townships. Until work has been initiated in all the townships, it may be that all a township volume will contain will be in its index showing where records affecting it will be found in other volumes.

I have found it advisable not only to use abbreviations for the thirteen general subdivisions of a section, but also to use abbreviations for the descriptions pertaining to these divisions. That you may better understand the index, I here reproduce the index of section 35 of township 19 north of range 46 west, as appearing in field memorandum volume numbered 1-9-6, and follow it with the index of the adjoining section to the south, or section 2 of township 18 north of range 46 west, as it appears in the second volume of this township or volume number 2-8-6.

Page 35, Vol. 1-9-6 (1st Vol. Field Memo. T. 19 N. R. 46 W.)

NE: Agreement as to corner, 46-48; LPP and LC Est-Per, 49-50 (the figures refer to pages).

N¼: Agreement, 46-48; LC Est-Per 48-49.

NL: RBch, 44.

NW: GC D-Per 44-46.

W¼: PC. Est-Per, 51-52.

WL: RBch, 42.

SW: 52-53, 1-8-6; GC. 61-64, 1-8-6; W. 156, 1-8-6. (These are page numbers in Vol. 1-8-6, or Vol. 1, T. 18 N. R. 46 W.)

S¼: PP 41, PC Est-Per 58-59.

SL: RBch, 51-52, 61, 126, 1-8-6; T1Ch, 41: E¼/¼ Est-Per 57-58: W¼/¼ Est-Per 59.

SE: PC. Est-Per 65, 1-8-6.

E¼: Agreement, 46-48; LC. Est-Per. 50-51.

EL: RBCh. 41.

INT: ¼Cor. Est-Per. 52-53. S¼/¼ Est-Per. 55-56. SW1/16 Est-Per. 56. SE1/16 Est-Per. 57. Lat ¼ Line, 52. E¼/¼ Est-Per. 53-54; W¼/¼ Est-Per. 54.

Page 2, Vol. 2-8-6 (2nd Vol. Field Memo. T. 18 N. R. 46 W.)

NE: PC. Est-Per. 65, 1-2-6.

N¼: PP. 41, 1-9-6; PC. Est-Per. 58-59, 1-9-6.

NL: RBCh. 51-52, 61, 126, 1-8-6. T1Ch. 41, 1-9-6. E¼/¼ Est-Per. 57-58.

NW: Sh. 52-53, 1-8-6; GC.D-Per. 61-64, 1-8-6. W. 156, 1-8-6.

W¼: Sh. 90, 1-8-6; PC. Est-Per. 153-155, 1-8-6.

WL: RBCh. 65-66, 1-8-6; RB, 103, 126, 1-8-6. S¼/¼, 155, 1-8-6. N¼/¼, 155-156, 1-8-6.

SW: GC.D-Per. 87-90, 1-8-6; W. 153, 1-8-6.

S¼.

SL: RBCh. 86-87, 1-8-6.

SE:

E¼:

EL:

INT:

So far I find I have used eighty-seven different abbreviations or combinations of abbreviations. The more common ones are: "R," for random line; "T1," for true line; "B," for bearing or direction; "Ch," for chained distance or length of line; "LPP," for latitude or proportional point or the proportional point on an east and west line; "MPP," or meridian proportional point or the proportional point on a north and south line; "GC," for government corner; "PC," for proportional corner, or a corner re-established according to law where a government corner is not found; "LC," for local corner, or any corner not a government corner or a corner not known to be re-established by proportional measurement according to law; "Des" or "D," for description; "Est," for established; "Per," for perpetuated or the description of the remarking of the corner or of its establishment; "Sh," for search, or the description of the search for the missing corner; "Ev," for evidence, testimony or information concerning a corner; "W," for witness or the bearing of some point in relation to the corner; "E¼/¼" and "W¼/¼," also "S¼/¼" and "N¼/¼," are, respectively, the east, west, south or north quarter-quarter section corner points when within a section, but when on the boundary their position is denoted by the particular line; "SE 1/16" or "SW 1/16" refers to the corner at the center of the southeast or southwest quarter sections of the given section. Applying these meanings to the foregoing index pages, the matter will become very plain and easy of understanding.

I find this system of indexing in the field memorandum works all right as long as not more than two volumes are used in any particular township, but when there are more than that, there should be a special index volume for the township.

Publications Received

A paper by R. E. McDonnell, Interstate building, Kansas City, Mo., on how to conduct bond campaigns, before the Kansas League of Municipalities, has been issued as a separate pamphlet and can be obtained on request.

A paper before the joint meeting of the Illinois and Iowa sections of the American Water Works Association by J. H. Dunlap of Iowa State University on "The Sanitary Drinking Fountain," has been reprinted separately for distribution.

MACHINERY AND SUPPLIES

Machine Finishing of Concrete Roads

The article on concrete road construction prepared by M. DeGlopper, county engineer, Pontiac, Mich., which appeared in the April, 1916, issue of MUNICIPAL ENGINEERING, went into considerable detail as to the machine-finishing of concrete roads in Oakland county, Michigan. The comparisons between hand and machine methods of finishing made by Mr. DeGlopper at that time were based on practical experience resulting from his own work, but this method of machine finish has since been developed and improved in various ways.

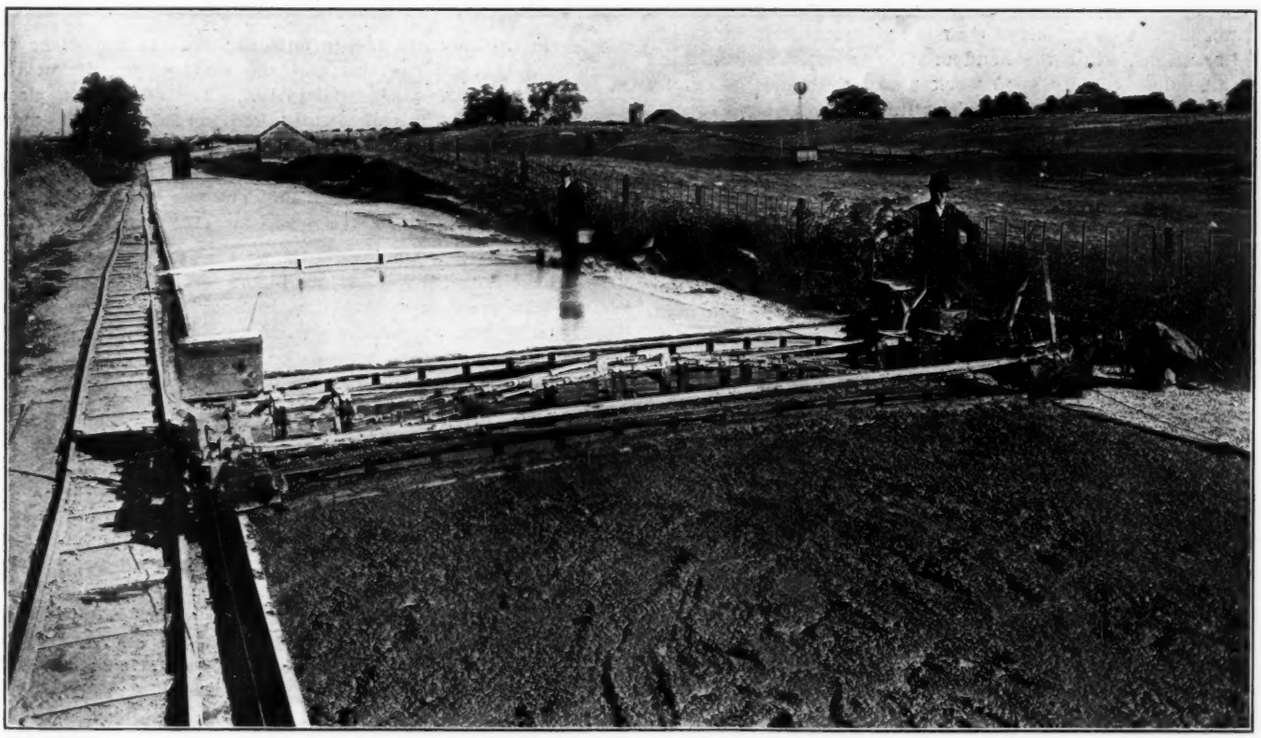
A new joint-installing device, which consists of a frame carried on two truck wheels is now drawn by the finishing machine itself.

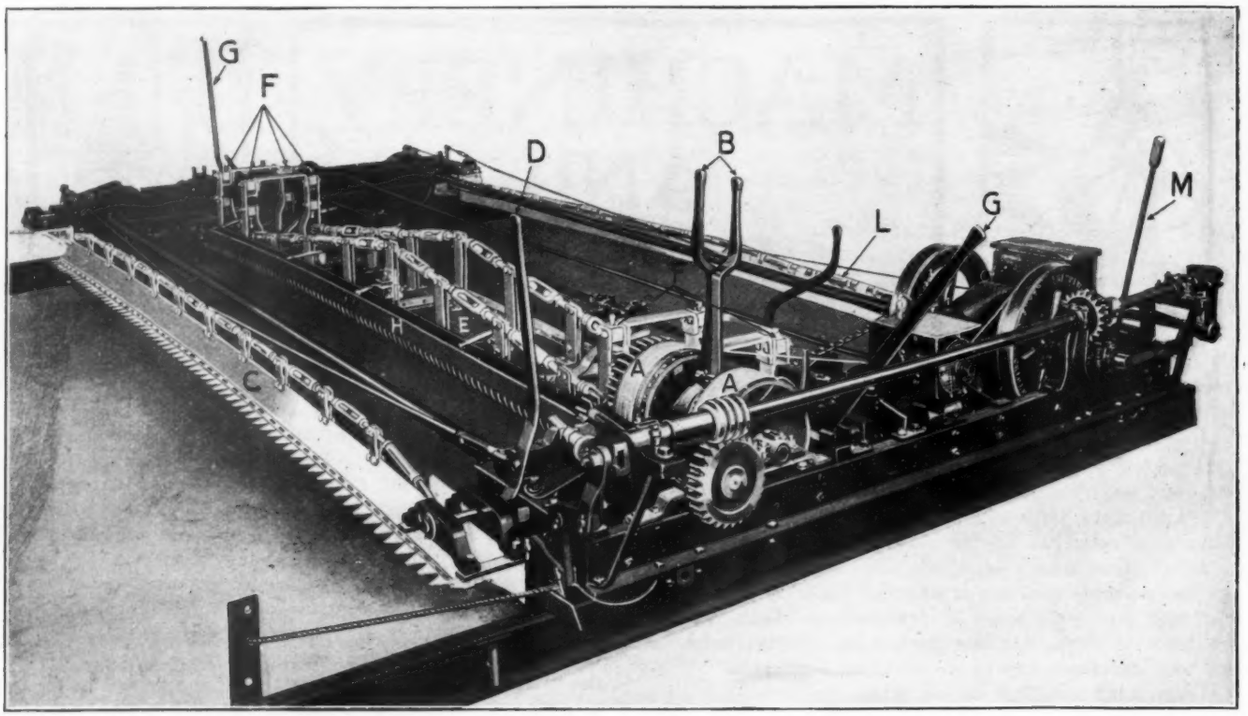
The joints are first placed with tops 1 inch below finished surface grade, the filler between the steel plates being allowed to extend a distance of approximately 1 inch into the subgrade, banking both sides with a little earth, thus permitting the machine to pass along as tho no joint were there. This method permits of an equal density of concrete on each side of the joint, a result not obtainable by hand finish, in which case it is necessary to strike up to the joint and lift over, and then go on from the other side, leaving an excess of material at the joint. This excess usually has a preponderance of coarse aggregate and therefore makes a high joint of different quality than the concrete in the balance of the pavement.

After the finishing machine has passed over, comes the apparatus which is towed behind it, which consists of a bridge on wheels with a framework to which tongs are attached. A lever is thrust down, causing the set of tongs to catch the steel plate joint and gently lift it to grade with a slight rocking motion, which tamps the concrete around and under the plates as they are gradually brought to the surface. Stops are provided, which prevent the raising of the armor plates above the correct position, and it is stated that this method guarantees that there shall be no excess material at the joint.

By means of the above method of installation an absolutely vertical joint is assured. The installing bar holds the joint in position above, while the extending of the filler into the subgrade insures a perfect alignment. When the joint is pulled up, as previously stated, it is an easy matter for the finisher, operating from the bridge, to give the concrete a few finishing touches on each side of the joint.

The R. D. Baker Company, contractors, Detroit, Mich., have perfected the above type of finishing machine on their own work in Wayne and Oakland counties, and while the machine effects a considerable saving in labor, they do not consider its





labor-saving ability alone as its chief advantage to the contractor. "We perfected this machine," states Mr. Baker, "in order to improve the quality of our concrete as well as to render it free from waves, depressions or irregularities of any sort. The securing of a uniform, dense concrete is of more real lasting advantage to the contractor than any mere dollars and cents saving in operation, especially where a maintenance is called for, and we have proven in our work that machine-finished concrete road will not ravel.

"The machine finishing of concrete roads eliminates the personal equation in the finishing process. The machine is always on the job and ready to do its work, whereas hand labor cannot always be depended upon. The machine is automatic in its actions, while the hand finisher is not. The finishing machine does equally good work all of the time and night-outs and hot weather do not affect it."

Edward N. Hines, chairman of the board of county road commissioners, Wayne county, Michigan, in describing the machine finishing of concrete roads, puts emphasis on the same points and adds:

"Then, again, the finishing machine permits the placing of the mixed material in a drier state. The machine thoroly tamps and kneads under compression, thus not only assuring greater density to the concrete, but a uniform density thruout. For these reasons the use of the finishing machine results in a decided gain in the quality of the finished road. Water pockets and air bubbles are eliminated and a more homogeneous concrete is secured. If side forms are firmly staked to line and grade, results secured by using a finishing machine cannot be obtained in any other manner.

"The finishing machine finishes the concrete surface immediately behind the mixer before initial set takes place, whereas the initial set is apt to be under way before hand finishers can get in their work.

"The spots, filled with laitance washed in by the water, are very noticeable on account of their chalky white deposit, which can be scratched by the fingernail."

"We were the first to operate a Baker finishing machine," states George F. Key, engineer of the same board, "and this machine has been perfected to a large extent on our work.

"Thru use of the finishing machine it is not necessary to use such a wet mixture—we need use only the correct amount of water (about 27 per cent.). The machine kneads the concrete while under compression, which is better than tamping, and this kneading action at the same time eliminates the bubbles of air which get into the concrete while mixing in the drum. The machine enables us to finish the concrete close to the mixer before the initial set takes place and its kneading assures that the concrete as it is laid on the sub-grade is as uniformly mixed as when in action in the revolving drum.

"The surface of a machine-finish road is very different from that of a hand-finish road. To begin with, there is no excess water in the concrete and in finishing close to the mixer we immediately compress and seal the surface, permitting the initial set to take place undisturbed. The result is a glass-like glaze, grayish in color, while the hand-finish road is more apt to be a chalky white. Of course, the difference in color depends a great deal on the kind of cement used, but the above statement is true in the long run. The sun will glisten on a machine-finish road, whereas it will not on a hand-finish road.

"Many visiting engineers in walking over our concrete roads have detected a difference in the feel of those that were finished by hand, as compared with those finished by machine. The machine-finish road has such an even surface as compared with the projections on the surface of the hand-finish road that the difference is very noticeable. In other words, the difference between the two surfaces is noticeable to the casual observer. There is no gritty feeling to the sole of the shoe, as the machine-finished surface is uniformly even and hard.

"The Baker finishing machine which we are using consists of two trucks, each having two wheels, and the two being connected by the strike compression pan and finishing float. The two cables, extending to the left and attached to the side forms, are used to move the machine forward at a rate of approximately 90 ft. per hour. This is accomplished thru the winding of the cables around the two power-driven drums AA shown in the accompanying lettered drawing. These drums, which operate independently by the two vertical levers, B, per-

mit one end of the machine to be moved ahead of the other when desired, so as to allow finishing around a curve.

"C, extending between the trucks, is the strike, which is adjustable vertically thru the lever, D. This strike oscillates transversely and is adjustable to different crowns by means of the turnbuckles.

"The compression pan, E, crowned with turnbuckles, can be adjusted vertically with the cap screws, FF. These screws permit the raising of the front edge of the pan higher than the rear edge and with the pan so set a large part of the weight of the machine, as it moves forward, is taken off the side forms and carried by the pan itself resting upon the green concrete, and it is this action which compresses the concrete at about 80 lbs. per sq. ft. It is this compression which squeezes out the excess air and water.

"The levers, GG, raise the pan vertically. The agitator, H, with fingers extending back under the pan, oscillates transversely, thereby kneading the concrete under the pan, and it is this kneading under compression which produces a uniform grade of dense concrete over the entire surface.

"The finishing float, L, smooths out any corrugations left by the pan. This float, which oscillates transversely, can be raised or lowered with the lever, M, and is adjustable to crown by means of turnbuckles.

"Altho this type of finishing machine weighs approximately 3,600 lbs., this weight is mostly distributed onto the green concrete along the compression pan."

Elmer G. Rice, secretary of the Wayne county road board, thinks the machine "adds at least one-third to the life of the concrete road without extra cost to the taxpayer."

William H. Ryan, contractor, Lansing, Mich., states that "one of the chief advantages of this type of finishing machine rests in the contractors' ability, thru its use, to do uniformly good work with unskilled labor. Any man, who can oil it, can run it.

"Taking it for granted that proportions of mix are right and that the material is the best and that the road has the proper thickness to support the traffic it is intended to bear, the surface of the concrete road is the most important and vital feature of its construction, as on the surface depends the success of the finished pavement. Where small depressions occur in the pavement we are apt to find one deep depression where two small ones formerly existed, as traffic so tends to aggravate them. Every point of contact marks a spot where abrasion will set in. I would therefore say, make your mortar, if possible, as dense as the coarser aggregate and thoroly bed the aggregate in the mortar. This result can only be accomplished by taking the concrete after it is thoroly mixed and knead it as it passes under the compression pan, thus eliminating the air bubbles and excess water. One of the chief advantages of the finishing machine rests in the fact that it permits the use of a concrete of jelly-like consistency, a concrete which does not run but stands up and barely settles down under its own weight. It would be impossible to strike or float such concrete by hand, yet this quality of concrete has just the proper percentage of water to give the greatest tensile strength.

"The machine does its tamping thru compression and the area of the compressing pan is so great that the concrete does not become displaced or squeezed out from beneath it, as would be the case were it feasibly practical to tamp it by hand."

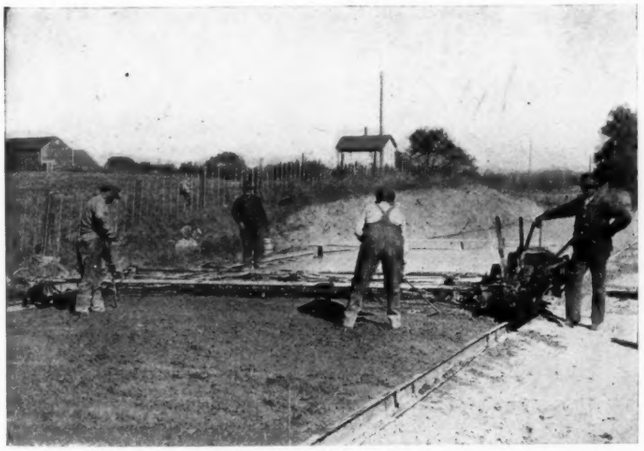
One of the reasons for the success of the finishing machine in producing a superior concrete surface lies in being able to finish close to the mixer, and consequently to strike, tamp and finish the concrete before the initial set has progressed to any extent. On this subject, Chairman Hines says:

"The writer has noticed that many concrete roads lose a thin layer of surface shortly after being opened. The concrete below does not flake off like this top layer, but 'dusts' and does not seem to have the stability to resist wear, altho a strong mixture was used.

"Some time ago a contractor who has put in a large number of concrete factory floors in Detroit stated that his success in building floors that do not 'dust' is due to the fact that the concrete is finished immediately after being removed from the mixer. When asked if it wasn't hard to keep the finishers so close to the work, he stated that he considered this so important that the mixer was stopped if the finishers were getting behind, until they caught up.

"There is no question that some floors and concrete roads dust and ravel, and if immediate finishing is the solution of the former, why not of the latter?

"The writer has often seen finishers working 75 feet or more behind the mixer. Figuring that the gang lays 500 feet per day, that means the concrete has been out of the mixer 1½ hours. What is the effect when the finisher retempers the mortar in floating so long after it has been mixed? The initial set has been destroyed. Most specifications for concrete construction today call for the rejection of concrete that is not deposited in the forms within thirty minutes. The concrete road calls for more exacting specifications than building construction, for in addition to shear, tension and compression, we have abrasion. We, therefore, should not be lax in road specifications. The finishers should not be more than 25 feet



FINISHING MACHINE ON WAYNE COUNTY ROADS, DETROIT. BAKER SIDE FORMS AND ARMOUR PLATE USED.

SETTING BAKER INDESTRUCTIBLE SIDE FORMS.

MACHINE FINISHED CONCRETE ROAD. BLOOMFIELD HILLS, WOODWARD AVE., NORTH OF DETROIT.

behind the machine if initial set is to be allowed to take place uninterruptedly thirty minutes after mixing.

"Some time ago an experiment was made to obtain a more even surface. A hand strike was sawed six times over a 25-foot section of road, after which it was finished with a hand float. It looked beautiful to the eye—so even—but, shortly after traffic was turned on to it, a layer about ⅛ inch in thickness came off, exposing the pebbles beneath. The exposed concrete was hard thru the tamping caused by the excessive striking, but the top layer, which was continually disturbed by the strike, lost its initial set and the bond to the lower material.

"The chemical action of setting in the cement begins as soon as the cement comes in contact with the water. We should continue mixing the aggregates, cement and water up to a certain time, not to increase the chemical action, but to mix the ingredients thoroly so as to get an even quality of concrete. It is found if we mix longer than this time we get a weaker quality of concrete. Why? Because we had it mixed and the continual turning of the drum is interfering with the setting.

"Let us assume that we have turned it over in the mixer drum just the right length of time to get the strongest mix. We pour it out on to the grade, which is further mixing. Workingmen tramp into it, level it off and strike it, which is further mixing. Then, after it has been out of the mixer an hour, along comes the finisher with a wooden float. He slushes the mortar top around in the excess water that has come to the surface, which is further mixing.

"We have mixed the concrete in the drum until we have obtained the greatest efficiency out of the cement and then continued to mix or temper it, which, experiments prove, will decrease the efficiency. Then we come on and destroy the initial set by late floating. What is the result? Haven't you noticed the flakes that come off a concrete road soon after traffic is let on? That together with continual dusting is the result.

"Many engineers agree that the concrete should be finished close to the mixer, and in order to do this easily they make the mixture very wet. The slushing of the excess water in the mortar with the float will not produce good concrete, to say nothing of the cement that has run to the sides with this water.

"Mix your concrete dry by using the correct percentage of water. There will then be no excess water to evaporate and make voids in the concrete. It is true the striking, tamping and finishing of such concrete will cost more than the sloppy kind, but the wearing surface produced is worth ten times the cost.

"Concrete roads will last indefinitely if destroyed thru wear alone. Raveling is what destroys them and that takes place when the hardness of the mortar is not on a par with the coarser aggregate and allows it to loosen and be picked out.

"Mix your concrete the proper time, deposit it on the grade, crown and float it at the earliest possible moment, and let nature do its work uninterrupted."

Holt Company Cuts Costs With Heltzel Loaders

C. S. Kauffman of the Holt Construction Company, Denton, Md., reports a considerable saving as a result of unloading material from cars with the Heltzel lightning unloader. In reply to an inquiry regarding the exact saving effected in his work, Mr. Kauffman recently said:

"Unusually strong, light construction and low cost were the features that first interested us in the Heltzel. These things decided us after the weight and expense of the ordinary loader had kept us on the fence for some time.

"As we expected, we found that the light weight was appreciated by the men, who have no liking for such a device unless it lightens their work. A trial order of one decided us that these were the things we had been looking for.

"At present we have three Heltzels on the job all the time, and find that we are doing our work with about one-third less labor and a corresponding cut in the pay-roll. The men work

faster and steadier to keep the skips full and when a wagon comes along it is loaded up in a jiffy. We are using 1½-yd. dumps and the loading time is considerably under a minute. Right there is a saving of 10 or 15 minutes for every load.

"Easy installation is a big point in favor of these loaders and we also find that they stand up wonderfully under hard usage. When we need more we will certainly buy Heltzels."

The loaders used by Mr. Kauffman are standard Heltzel loaders which consist mainly of a steel skip pivoted between two brackets. Special design of these brackets makes attachment to the side of a flat car only a matter of a few minutes and when these are attached the skip is easily slid into place.

When routing of the automobile trucks to and from the car is arranged for best results there is always a full skip waiting with its load roady to be slid off as soon as the truck pulls under it. After the load slides off the skip immediately swings back to its horizontal position ready for the shovelers. Thus there are never any idle periods either for the truck or the laborers, making an all around saving that soon pays for the set of three loaders generally used for one car.

Parrish Template in Monolithic Road Construction

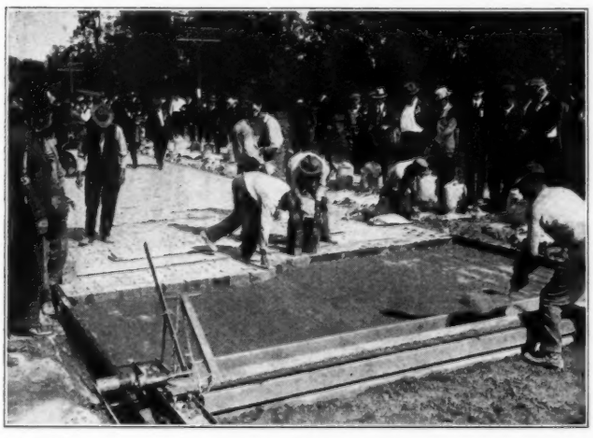
As a means of speeding up the construction of monolithic brick highways an ingenious template has been devised by Allan J. Parrish, who built the section of the Chicago highway near Paris, Ill. This template is simple in construction and provides the smooth bed necessary for a well built highway.

The Parrish double template consists principally of a forward cutting edge (an I-beam) and a rear cutting edge (a channel with the flanges placed outward) between which is a space to receive the luting mixture. Details of this construction may be seen in the illustration which is here reproduced. The I-beam and the channel are spaced from 2 to 3 feet apart. The bottom of the rear cutter is about 3/16 inch higher than the lower edge of the forward cutter. In use the space between the cutters is filled with a mixture of dry sand and cement so that after the template in motion has cut off the concrete surface to the proper form the luting fills all irregularities in the surface.

In working with the Parrish template the road to be paved is first covered with concrete mixed to a quaky consistency, the surface of which is roughly struck off with shovels to a depth of about 2 inches greater than the required depth of foundation. The template is then filled with a dry pre-mixture of equal parts of sand and cement and the foundation struck off and luted. Forward motion of the template is obtained either by a chain wound on a specially prepared drum on the mixer or by driving the mixer ahead on the planking.

It is found that the surface left in the rear of this template is remarkably smooth, entirely free from depressions and ready at once to receive the brick surface. Bricks are laid in the usual manner, the dropper standing on the brick just laid, which even at this stage have sufficient rigidity to resist the formation of any depressions in the surface due to workmen moving about.

Where the Parrish template is used the brick is set immediately by rolling with a 400 to 500-pound hand roller and the surface produced in this way is found to be remarkably smooth.



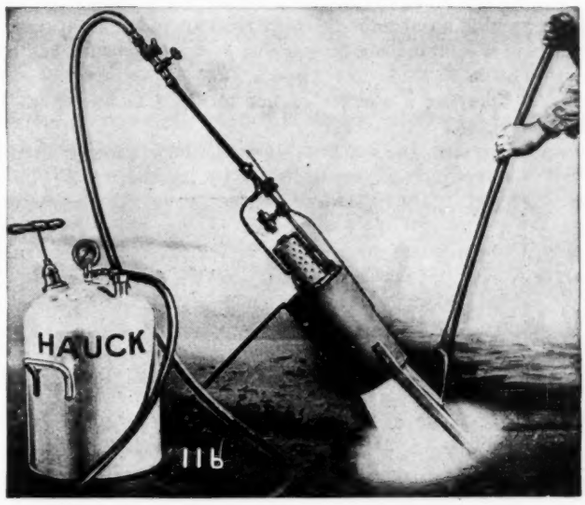
Thawing Out Frozen Ground

We are illustrating a popular type of burner for thawing frozen ground.

The distinctive features of this outfit will be found in the burner itself, it being of a patent vaporizing type which operates without compressed air. Where used in the open it is made with special housing for protecting the flame and preventing its becoming cool too quickly when shut down or starting up intermittently.

The burner has its own combustion chamber and delivers a blue-reddish flame. The oil storage tank is equipped with a quick acting 2-in. diameter heavy brass pump which forces the oil to the burner. From 30 to 60 lbs. of pressure may be obtained within 2 to 3 minutes and will last 3 or 4 hours.

The method of applying the flame for thawing out frozen ground is shown in the illustration. The burner is resting on



HAUCK HAND PUMP OIL BURNER FOR THAWING OUT FROZEN GROUND.

a stand which is made in the form of a shield for protecting the burner from the wind or draught. It helps to concentrate the flame in the manner indicated.

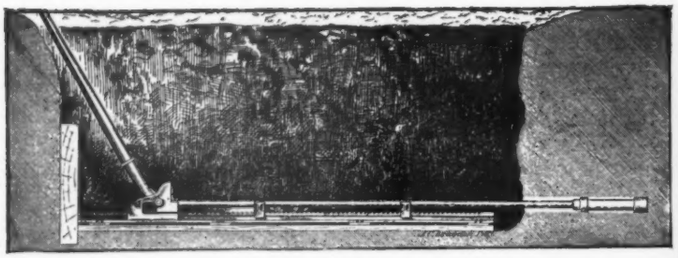
A hole 2 ft. wide and 3 ft. long into 12 in. of frozen ground was dug within 18 minutes. This was accomplished by applying the burner and loosening the frozen top surface, after which the crowbar and shovel were applied and the loosened materials removed, after which the burner was again applied.

This outfit was especially designed for digging ditches, for opening up frozen streets, for repairing gas mains, fire hydrants, etc.

Forces Pipe Under Pavement

We are illustrating a popular method of driving pipe up to 4-inch diameter under pavements.

The Barret forcing jack consists of a malleable iron cage traveling on a steel rack with machine-cut teeth and operated



by the handle. At the front of the cage is a groove and clamp for holding pipe of ¾ to 4-inch diameter. The rack is provided with foundation plates and bolts for securing a plank, and also carries two guides for holding the pipe in line. The interior working parts are of steel, heat treated. The jack will work against any resistance up to 30,000 pounds.

This jack has a travel of 7½ feet. The trench should therefore be a little longer than this, and the pipe cut in equal lengths, not over 7 feet 4 inches long. If it is desired to use longer pipe, say 14 feet lengths, the trench must be correspondingly longer, and a short piece of pipe, about 7 feet 4 inches long, to be used on every other run out of the jack, to force the end of the permanent service pipe its full length into the ground, making room for the next full length of pipe in the trench. The former method is usually preferred.

Air-Cleaned Roads for Asphalt Treatment

To provide an absolutely clean road surface for bituminous treatment a combination blower and asphalt spreader has been devised by S. E. Finley, of Atlanta, Ga. This system of cleaning and applying a surface of hot bitumen is known as the Finley method.

As illustrated, the machine used is a large blower mounted

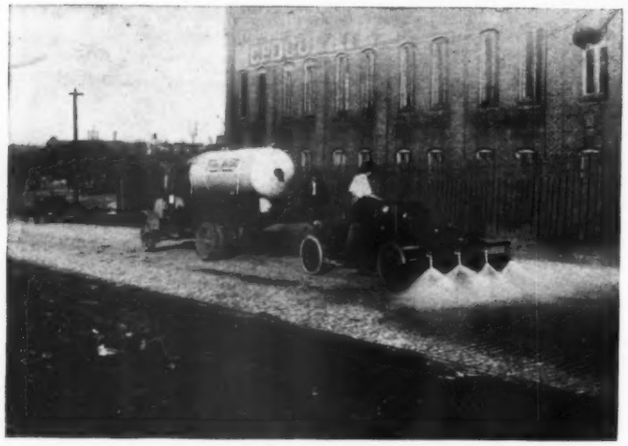


FIG. I.—FINLEY METHOD SPRAY BINDER ON FRESHLY CLEANED ROADBED.

on a motor truck, this blower being chain-driven from the main shaft and capable of delivering 6,000 cu. ft. of air per minute at a pressure of from 2 to 3 ozs. Air is projected on the road surface thru a longitudinal slot at the bottom of a horizontal flue, and removes all dust by blowing it slightly ahead of the openings. At the same time the hot binder is forcibly sprayed onto the newly cleaned surface by 4 special rotating nozzles. This binder is sprayed onto the road at a pressure of about 60 lb. per square inch.

As shown in Fig. 1, the supply of binder is carried in the large tank mounted on a motor truck, thus being delivered under pressure to the distributer.

Fig. 2 shows the air blast in operation throwing up a cloud

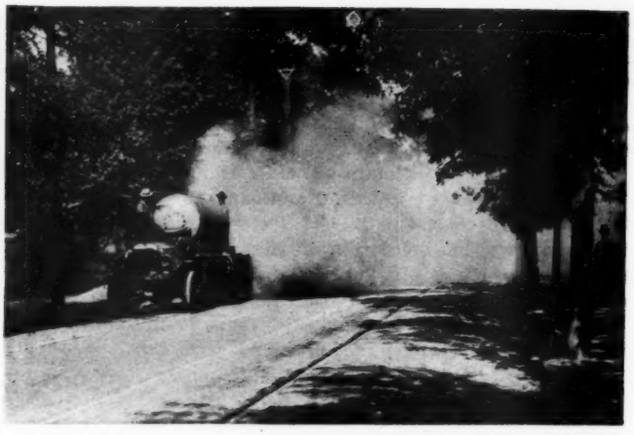


FIG. II.—BLOWER OF THE FINLEY METHOD THOROLY REMOVES ROADBED DUST.

of dust, which entirely obscures the combination blowing and asphalt-distributing device. In Fig. 3 is shown the same surface before cleaning, and it could hardly be seen from inspection of this view of an apparently clean pavement how so much free dust as is indicated by the preceding view could exist.

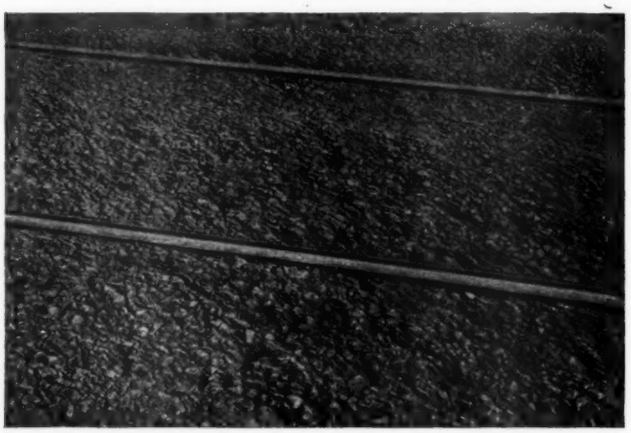


FIG. III.—APPARENTLY CLEANED ROADBED BEFORE IT WAS FINLEY CLEANED, AS SHOWN IN FIG. II.

It is claimed that these machines can be very closely regulated to distribute from one-sixth of a gallon per square yard to over two gallons, and in all cases providing a uniform layer on the roadbed.

With the Finley machines, which are not sold, but are leased under an agreement with the manufacturer, it is said that bituminous binders can be applied for a cost as low as 6c per gallon.

Shovel on Sewer Excavation

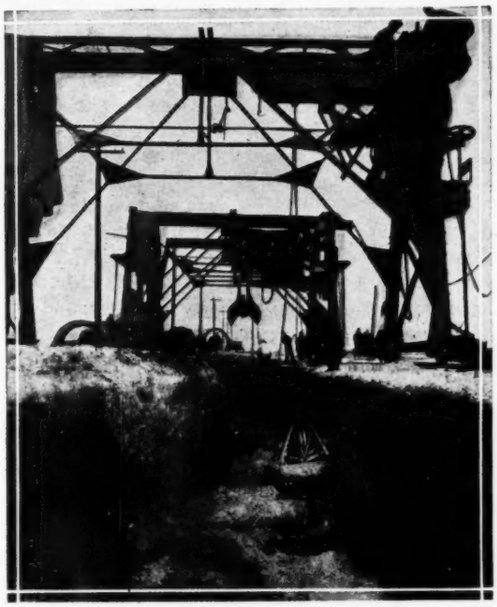
There are two reasons in particular why the Salt Lake City project, known as the West Side Outlet Sewer, is so decidedly interesting.

Reason number one is the special machinery used, whereby the constructing cost has been reduced. Number two is the fact that practically all the equipment is electrically operated.

The work consists of laying a main trunk reinforced concrete pipe sewer about 22,000 feet long, and the necessary excavation therefor. The pipe varies in diameter from 42 inches to 78 inches, inside measurement. The excavation involves about 150,000 cubic yards.

The contractors for this work are Gibbons Brothers, Reed & Roche, of Salt Lake City.

Before any of the trench has been dug, work was begun in making the reinforced concrete locked joint sections of pipe.



VIEW OF TRENCH, SHOWING THE SHEET PILING AND TWO ELECTRIC CRANES.

Instead of casting this pipe all in one yard it was made along the lines of the sewer, to save the cost of hauling and extra handling. A certain amount of seasoning is required before the pipe is put in place. The preliminary drying process was accelerated by the use of steam coils.

A section of 78-in. inside diameter pipe, 4 ft. in length, weighs about 9,100 pounds.

The depth of the trench, or ditch, varies with the contour of the ground, and the fall in the system. The greatest depth is approximately 20 ft. The width of the trench is governed by the size of the pipe, the maximum width being 10 ft. 6 in.

Considerable of the equipment used on this work was especially designed by its contractors, and the method of laying the pipe, which is said to be somewhat out of the ordinary, is as follows:

The center line of the sewer is staked out by the city engineers. An Osgood steam shovel No. 18 with a ½-yd. bucket and a special length of boom stick first digs out a ditch about 6 ft. deep and of the required width.

The shovel itself is supported by the timbers laid across the opening. This bridge is carried along by the shovel picking up sections of it from behind and placing them in front in the direction of travel.

The steam shovel is followed by a traveling pneumatic pile driver. Locked steel piles 20 ft. in length are then driven along the walls of the shallow ditch until the tops are flush with the original surface. Timber braces are next put in place to prevent the piles being forced in by the pressure of the ground on the outside. Two traveling cranes now follow, each having a ½-yd. clam-shell bucket which takes out the dirt to approximately the proper level on which the pipe is laid.

A certain portion of the ground removed is used in filling up again and the balance is carted away. The steam shovel and clam shells load directly into the carts or wagons.. The gage of the rails on which the cranes travel is wide enough to permit these wagons to travel between the outside rail and the edge of the ditch.

The third traveling crane raises and lowers the bridging timbers between the piles, sets the sections of pipe in place and afterwards pulls the steel piles. This crane is assisted by a special steel derrick for lowering the pipe.

The various sections of pipe are cemented together so as to make the line continuous.

A Pawling & Harmisfeger back-filler fills up the trenches.

Wire rope was an important factor on this work and Hercules was on the job.

All the equipment with the exception of the steam shovel is electrically driven. Practically all the structural steel work is made in Salt Lake City. The hoists are supplied by the Sprague Electric Company. The air compressor that supplies the pneumatic pile driver is moved along as the work progresses.

The territory which this sewer will drain lies low so that seep water is encountered at a depth from 6 to 10 ft. and this makes it necessary to take extra precautions against cave-ins and raising of the ground in the bottom of the trench.

Shovel Lifted by Crane

After the 18-ton shovel that had been used by the city of Chicago for excavating to a depth of 50 ft. below the ground surface had completed its work, the question arose of how to get the shovel out of the pit with the smallest cost. A Browning locomotive crane had been used on the job for unloading sand, gravel and other construction materials.

The crane was run up to the pit on a track laid for that purpose. A ¾-inch Hercules wire rope was let down; a fastening was made in the shovel; the engine throttle was opened, and the deed was done.

The excavation in question was in connection with the construction of the Mayfair pumping station under the direction of F. Carl Martini, resident engineer, and E. S. Henry, general foreman of the engineering department of the city of Chicago.

A connection was made to the shovel by means of a chain passing around it under the truck. Before the shovel was raised its dipper and boom were removed, which made the actual weight lifted about 16 tons. The shovel was raised and swung around on the ground in less than three minutes, at a 21-ft. radius, and this performance of the crane exceeded its rated capacity by about 33 1/3 per cent.

Removable Steel Culvert Mold

By means of an ingenious knock-down steel culvert-mold, which has just been devised, it is claimed that the cost of constructing concrete culverts can be reduced by at least 50 per cent. The mold is built strongly, but of very light weight, so that it can be easily handled by one man.

As illustrated, the device consists of two side rails, each provided with a special lock or catch so that they may be joined together by arched end pieces, as shown in Fig. 1. This catch is so arranged that when it is locked with the arched members of the form upright the two arches and two side beams are rigidly held together. When unlocked by pulling the two ropes shown, the four pieces of the form at once fall apart.

FIG. I.—PARTS OF KNOCK-DOWN CULVERT MOLD.

Interlocking steel sheets laid over the end arches complete the form.

Setting this form in place ready for use is only a matter of a few minutes. After the concrete has set the whole form is collapsed by simply pulling the two ropes, after which the steel is removed piece by piece, ready for a new job.

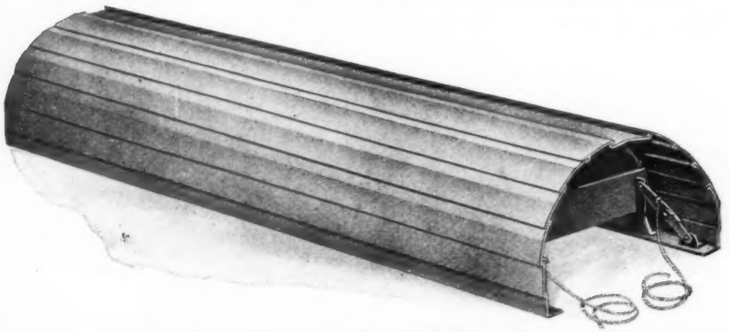


FIG. II.CULVERT MOLD ASSEMBLED READY FOR USE.

These forms are built in standard sizes for culverts 20 to 24 feet long, and with each set four pair of end arches are supplied, providing for four widths of sewers, from 20 to 48 inches wide. As the entire apparatus is made of steel and malleable castings it is good for a large number of culverts without noticeable depreciation.

Roller Cutting Attachment

A time-and-cost-saving method was used by the Stone & Webster Engineering Corporation for removing pavement in

connection with a street railway job in a Texas city. The bitulithic surface to be removed was about 2,000 feet long and 8 feet wide. For the job in question two pieces of 3 by 3-inch angle-iron were fitted to one of the wheels of a 10-ton steam roller, one side of the iron being sheared for a cutting

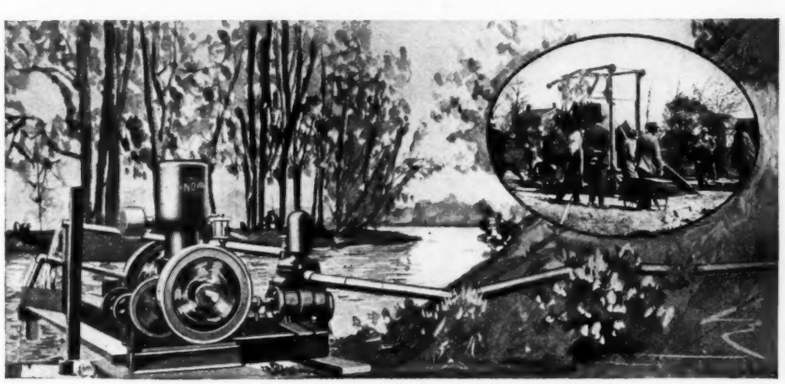
edge. Two white lines 8 feet apart were then painted on the pavement, to act as guides for the operation of the roller. As the cutter was placed on one wheel only, the steering was not difficult, and the weight of the roller drove the angle-iron thru the pavement. After two cuts had been made, each 2,000 feet in length, a gang of men rolled the pavement to one side. The device cost $10.

Pumps Water Two Miles

We are illustrating how a Novo type-U outfit solved a hard problem for contractor William H. Ryan of Lansing.

When Mr. Ryan set up his concrete mixer on west Main street, about two miles out from the city limits of Battle Creek, Mich., he found the nearest water supply was two miles away. He set up the outfit, as illustrated, on the banks of the Kalamazoo river, two miles from his mixer, started it going and left it. Until the finish of the job it supplied the mixer with more water than it could use, at about 75 pounds pressure, and without let-up or trouble of any kind.

PUMPING WATER DISTANCE OF TWO MILES TO MIXER. STEAH SHOVEL EXCAVATING TRENCH.



Concrete Tamper

The Andrews concrete tamper has projections on its face which force the coarse aggregates into the body of the concrete, and it is said that this makes it unnecessary to lay the concrete in two layers, as the operation of tamping brings the mortar to the top for a finish.

Trade Notes

The publicity bureau of the Associated Metal Lath Manufacturers has moved its offices to 901 Swetland building, Cleveland, Ohio, with Zenas W. Carter as commissioner in charge.

Anson-Byrne Company, Chicago, sales agents for various mechanical equipment, have new offices at 10 South La Salle street.

The business of August Mietz, Emma C. Rueff proprietor, has been transferred to the August Mietz Corporation, with Emma C. Rueff as president, Emil Rueff vice-president and treasurer, Otto V. Schrend, secretary; Louis C. Eitzen, general manager, and will be continued without change of policy under Mr. Eitzen's personal management.

F. L. Manning has become general manager of the Peebles Paving Brick Company, Portsmouth, O., succeeding S. C. Peebles, who resigns the duties of this position, retaining those of vice president and director. John Peebles is president.

Trade Publications

The National Paving Brick Manufacturers' Association has bound in one handsome cloth-bound volume three booklets on city streets, series 1, 2 and 3 and three on country roads, series 1, 2 and 3, which are really three sets of specifications for brick pavements, with the proper modifications to adapt them to street and to road pavements respectively. Series 1 in each set is on the sand-cement super-foundation type of vitrified brick street or road pavement, with cement grout filler. Series 2 is on the green concrete foundation type. Series 3 is on the sand-cushion type.

A portable meter, for testing service meters, is described in Bulletin No. 46291A, just issued by the General Electric Company. The purpose of a meter of this kind is to save time and labor, increase efficiency ,and eliminate such inaccuracies as errors due to fluctuating voltage, load, etc.

The Austin tandem motor roller, gasoline driven, is fully shown and its advantages stated in a recent circular of the Austin-Western Road Machinery Co., in Chicago, Ill., which will be sent on request.

Meter boxes for all climates is the theme of a recent circular of H. W. Clark Co., Mattoon, Ill.

The Clay Pipe Book, published by the International Clay Products Bureau, Kansas City, Mo., is a very valuable statement of the process of manufacture of clay pipe, the tests to be applied to drain tile and sewer pipe, and many novel uses of such pipe.

"Facts About Water Power," is the title of a pamphlet issued by the Water Power Development Association, Washington, D. C., which contains the data on which the organization bases its campaign for certain legislation by Congress on this subject.

FIRE DEPARTMENT

Fire Fighting in Years Gone By

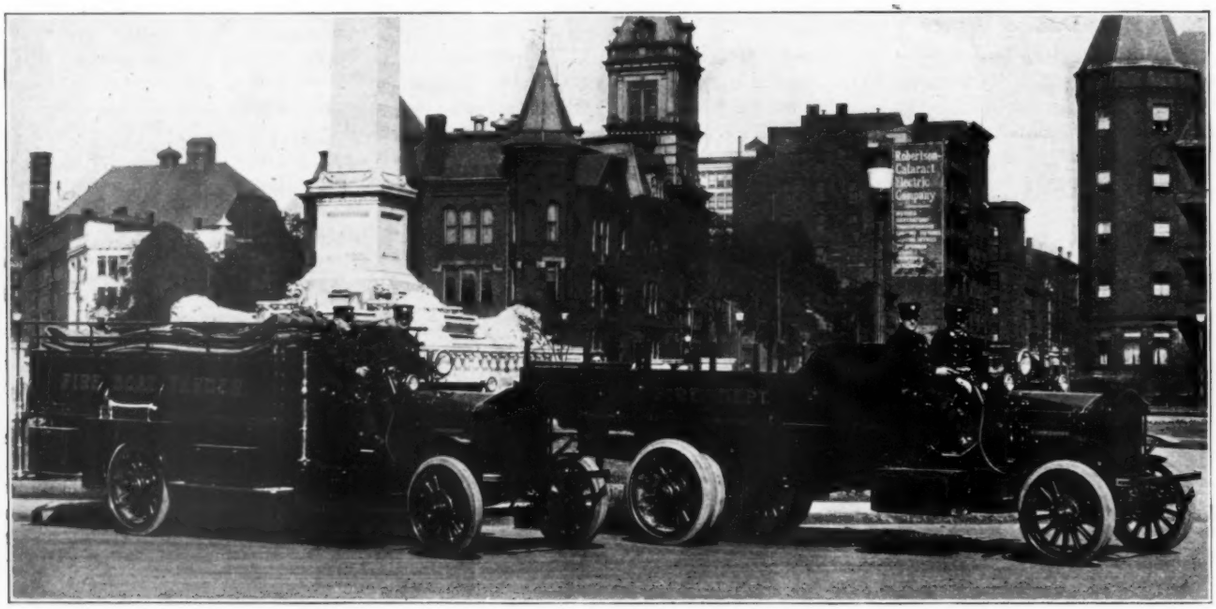
The precise origin and description of the earliest fire-fighting inventions are hard to find, altho ancient history intimates that they were devised and put to notable use in ancient Babylon.

There the problem was, how to raise water to the top of the high wall by which the city was surrounded. Herodotus tells us that the water was admitted into closed vessels or pipes, and then forcibly expelled on the principle of the bellows. Then for the first time water was forced perpendicularly up to the required height. This process, beyond doubt, suggested ultimately the fire instruments, sucking pumps, siphons, syringes; and these in turn suggested a kind of fire engine that for another long period waited on invention.

The earliest mention of fires and fire instruments in the city of London was by William Fitzstephen, who in about 1190 writes concerning them. John Stow dug up this matter, and in his survey of London, first published in 1603, made this observation: "It followeth in Fitzstephen that the plagues of the city in his time were an inordinate quaffing among fools, and oftener casualities by fire, the houses being then built all of timber and covered with thatch of straw or reed, it was long since thought good policy in our forefathers wisely to provide, namely, in the year of Christ, 1189, the first of Richard I, Henry Fitzalwine then meing mayor, that all men in this city should build their houses of stone up to a certain height, and then to cover them with slate or baked tile; since which, thanks be given to God, there has not happened the like often consuming fires as afore."

According to this authority, the only instruments then used against fires were hand squirts, syringes and axes, the like of the instruments that were used in a fire in Rome, described by Pliny. From these old times down to the great fire of London, September 2, 1666, it is certain that no considerable improvements in fire instruments were made. And from the date of the London conflagration down to the year 1834, when the first of Chicago's fires occurred, the inventive talents of all nations had produced few weapons for combating fires, and the best of them did not suggest, much less did they prophesy, the powerful steam fire engines and the accompanying paraphernalia that now are universally employed.

In the Chicago Municipal Library at the City Hall, there is a most interesting reprint, itself very old, of a remarkable pamphlet that originally bore the date, London, 1667. Some great names appear in it, names of persons who witnessed the going up of that city in flames. Among them were the diarist Pepys, who contributed a paragraph to the pamphlet, and John Ford, the poet and dramatist.



PIERCE-ARROW 5-TON APPARATUS AS OPERATED BY THE FIRE DEPARTMENT OF THE CITY OF BUFFALO, N. Y.

They had a bucket brigade in London, so much is certain, and it came into being at least two hundred and five years before Chicago's brigade of buckets appeared in 1833. And they had a pump service, which in some manner was connected with delivering instruments. What these latter were like is read in a description found in another old pamphlet in the Municipal Library, of a fire engine once employed there. "In the Guildhall Museum can be seen this fire engine (this was written twenty-one years after the fire), together with two others belonging respectively to the ward of Aldgate and the parish of St. Lionis Backchurch. These engines are brass hand squirts, the largest being three feet long, with a brass receptacle with capacity of from two to four quarts of water, to which was attached hose two and a half feet long and one inch in diameter; the base of the nozzle was one-half inch. Three men were required to work this engine—one on each side grasped the cylinder with one hand and the nozzle with the other, while the third worked the piston. Those who held the instrument plunged the nozzle into the water, the operator then drew back the piston and thus charged the cylinder; and when it was raised up to the required position he pushed the piston and forced the water on the fire, "like a fight with bayonets." China at that time had better instruments, and Germans were in advance of all other nations, and had their fire engines placed on carriages.

London had no fire bell. Alarms of fire were given by human voices, as told by one Wiseman, quoted in our pamphlet, "voices shrill, piercing, frightful. The great fire was advancing. Now the cry of fire in every street with horrid emphasis, is echoed forth; these dreadful screams disturb our midnight quiet."

A Squad Wagon of Many Uses

A squad wagon recently built by the city fire department of Los Angeles, Cal., embodies a larger number of aids in fighting fires and in saving lives than any similar apparatus in the United States, if not in the world.

Five 250-watt search lights, with lanterns 16 inches in diameter, capable of throwing a beam of light so strong that a newspaper can be easily read at 500 feet, yet so arranged with diffusing lenses that it does not blind the firemen even a few feet away, are mounted on the truck, three of them permanently and two so as to be portable, each being attached to 320 feet of heavy insulated cable on a reel which can be unrolled, permitting the lights to be carried anywhere within the limits of the cable. The lights will penetrate smoke to a surprising extent. The power for the lights is furnished by 8 batteries capable of furnishing current for the lights for 7 hours, or by a generator run by a silent chain drive from the main propeller shaft, which can be used to furnish current for the lights if necessary. As a precaution against accidentally speeding up the engine when it is driving the generator at a fire, a special protective device has been installed, consisting of a hood which can be lowered and locked in position.

A switchboard is mounted on the right side of the wagon immediately above the generator, which has a marble back in an enclosed case with a glass front. It is equipped with a master switch for the batteries and the generator, an individual switch for each light, ampere and voltmeters and a resistance cut-out, with fuses of proper capacity for each switch. An under-load and over-load switch prevents damage to the generator and acts as a governor, automatically to disengage the charging line from the generator when the rate of change gets to a dangerous height or when the rate of change is so low that this would be dangerous because of the batteries bleeding.

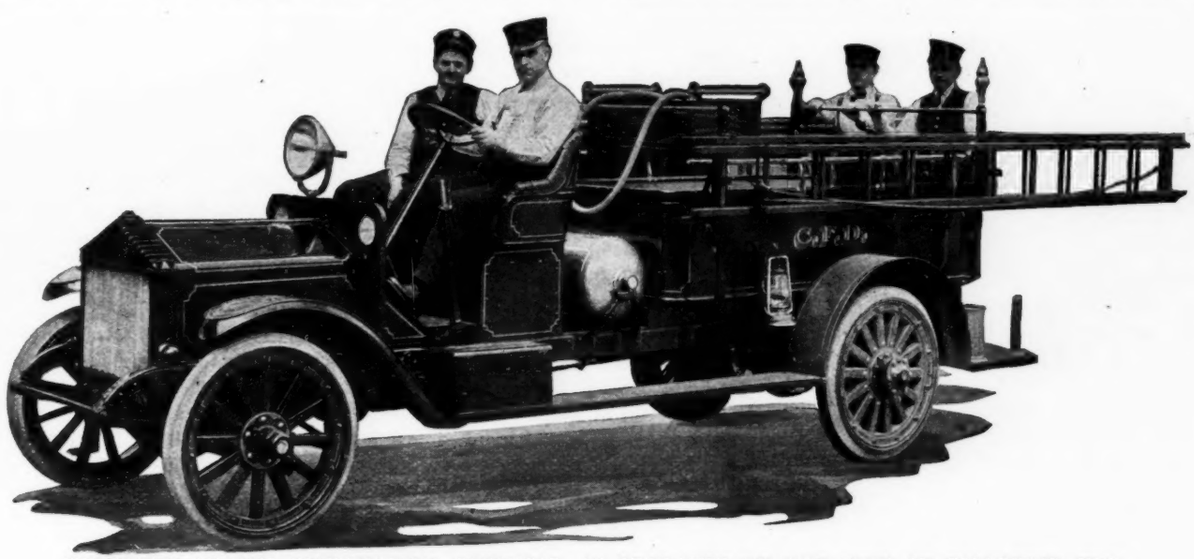
Each portable light can be operated on a tripod of heavy hard wood, carried in a special compartment in the rear of the wagon, which can be collapsed or extended very quickly. It is readily moved about by one man. The light may be used without the tripod, a large handle at the back of the light enabling a fireman to carry the light in one hand up a ladder. The strong rays penetrate the smoke, showing the location of obstructions or holes, openings, stairways, etc.

The three stationary lights may be elevated, lowered or swung from side to side, to illuminate the exterior of a building, fire escape, ladder or window, alley or street, to aid escape from building or collection of equipment.

Two of the latest improved smoke helmets are carried. The front of the headpiece is fitted with a heavy colored mica, which enables the wearer to see perfectly yet suffer no ill effect from the light or heat. The headpiece is heavily reinforced to protect the head from injury. A special gage indicates in minutes the capacity of the oxygen cylinder, thus giving warning of the necessity of getting a fresh cylinder of oxygen.

The operator carries a hand flash-light which allows him to make close inspection of dark places and to see the gage, to seek unconscious persons, open locked passages, close a valve from a gas main or bursted ammonia line, etc.

A strong signal line is attached by a snap to a ring on the appliance, by which signals may be transmitted in either di-



STEGEMAN 1½-TON COMBINATION CHEMICAL AS OPERATED BY THE CITY OF COLUMBUS, WIS.

rection by a pre-arranged code of jerks. It is snapped on so that it may readily be removed if it should become entangled or held fast by falling material. In case no signal is received in a reasonable length of time, men with other helmets would be dispatched to his rescue.

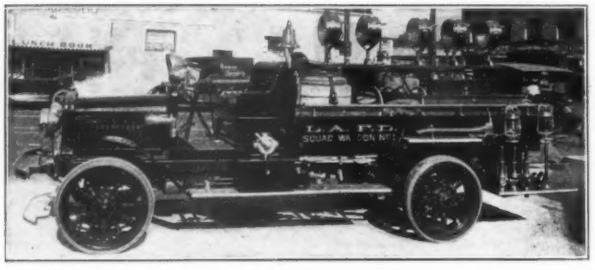
Another important piece of apparatus is a pulmotor to resuscitate persons suffocated from fumes, gas, smoke, etc., by producing artificial respiration. This works on one cylinder of oxygen for 60 minutes. Other fresh cylinders may be connected in 5 seconds. The wagon will make a special run to any point where this equipment may be needed, regardless of where the person may be. This wagon often makes runs to revive persons who become accidentally asphyxiated or partly overcome by gas fumes escaping from a gas stove. Different sized masks are carried for use on infants or adults, as the case may be.

There is hardly a fire of any consequence where some fireman or spectator is not injured, and to enable treatment to be immediately supplied, a complete first-aid outfit is carried. A trained member of the crew has charge of the outfit, which is portable, being provided with handles for carrying. It includes 25 bottles of drugs, such as iodine, antiseptic tablets, soda for burns, peroxide, etc. Also a good supply of absorbent cotton, scissors and probes, adhesive tape and a pan for bathing minor injuries.

Two portable collapsible stretchers are also carried for use in any emergency case where it may be necessary to transport an injured person from a building. Two heavy blankets are carried in connection with the first-aid outfit.

A portable oxy-acetylene cutting torch is carried on the wagon and is of such size and weight that two men can readily carry it to any point for immediate use. It is carried complete with cutter, gas tank and hose in a metal case 3 feet high by 18 inches square. It is used in cutting thru iron doors, steel columns and other kinds of metal to aid persons in escaping from burning buildings. The cutter operates on a mixture of oxygen and acetylene gas. A cylinder of each is carried equipped with the proper devices for operating the same. The strong light from this cutter makes it necessary for the operator to wear smoked glasses to protect the eyes.

An auxiliary tank of 25 gallons capacity is carried for the purpose of supplying gasoline to pumping engines. In order to eliminate the great danger of supplying a gasoline pumping engine with gasoline when a steam fire engine is near by



a hand pump with 50 feet of hose is carried. The wagon is driven about 40 feet from the engine. The hose is attached to the hand pump, which is screwed into the 25-gallon gasoline tank, the other end of the hose is attached to the gasoline tank of the pumping engine by special connections and the gasoline is delivered to the engine without coming in contact with the open air.

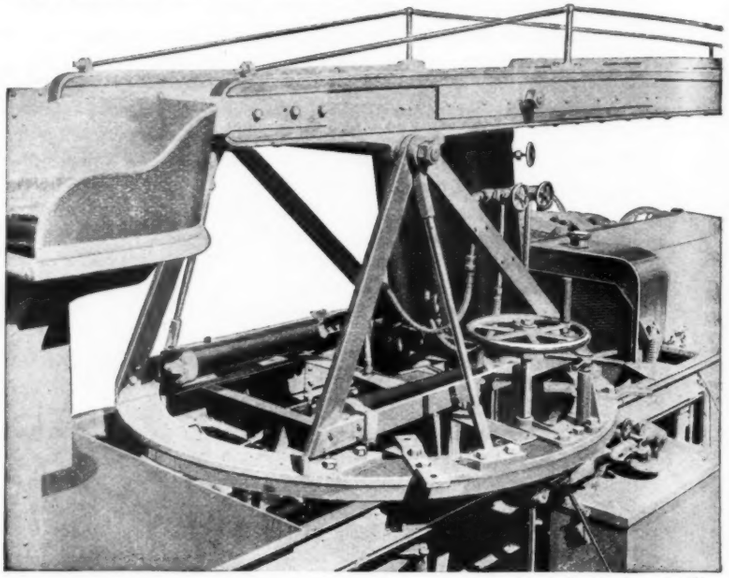
The truck is equipped with a 30-h.p. engine mounted on a 2-ton chassis and can make a speed of 30 miles an hour, which is as fast as it is safe to go with its delicate equipment. The crew is composed of four men, one of whom is a trained nurse. The wagon responds to all first alarms of fire within the downtown and business section, but is subject to special call to any point where it may be required.

The wagon was designed by E. H. Henry, mechanical engineer of the Los Angeles Fire Department, and was built by the department on a regular 1½-ton Moreland truck.

New Type of Turn-Table for Aerial Ladder Truck

The turn-table for motor fire apparatus, illustrated herewith, is of standard type, but in several respects presents a noteworthy innovation. The circles are forged and turned from high carbon steel, the upper ring being carried on ⅞-in. steel balls.

The hoist is of the Dahill compressed air type, liquid controlled, and consists of three 7-in. cylinders with pistons and rods. These cylinders are connected with trunnions with the turn-table and have free oscillating movement. The outer ends



of the piston rods are connected by trunnion to the main ladder. Opening one valve permits compressed air to flow freely into the bottom of the two outer cylinders.

The center cylinder is filled with oil and equipped with by-pass and air-chamber in combination. The opening given the valve in the by-pass piping regulates the speed at which the ladder is elevated.

The air-tank and motor-driven compressor are carried at the rear of the chassis frame. A single man with just one hand can raise and lower the ladder at will. The device is made by the Couple-Gear Freight Wheel Company, Grand Rapids, Mich.

What Worcester Is Doing

The city of Worcester, Mass., has 38 pieces of horse-drawn equipment in service, but is motorizing its complete department as rapidly as circumstances allow. During the current year 3 new pieces of motor apparatus were added, and the department is now motorized to the extent of 2 American-La France triple combination pumpers, 4 American-La France combination hose wagons and chemical engines, 2 Pope-Hartford combination hose wagons and chemical engines, 2 combination hose wagons and chemical engines, Netco chassis with superstructure built and mounted in the department shop by members of the department at headquarters, 1 Pope-Hartford hose wagon and squad car, 1 American-La France combination ladder truck and chemical engine, 5 chiefs' cars, 1 Thomas and four Buicks; 1 second-hand Locomobile for practice car.

Motor Apparatus in Fire Departments

(Continued from April number, page 199. See April number for explanatory note.)

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Oregon—													
Ashland	ch ho	Am.-La France	3	4	70	1,200	40	32	....	....	.....	.....	.....
Astoria	ch ho	Am.-La Fr. (2)	5	4	70	1,200	70	32	....	....	.....	.....	.....
Grants Pass	ch ho	Am.-La France	5	4	70	1,200	70	32	....	....	.....	.....	.....
LaGrande	ch ho	Am.-La France	4	4	70	1,200	70	32	....	....	.....	.....	.....
Marshfield	pp ho	Am.-La France	2	6	100	1,200	40	32	....	....	.....	.....	.....
Medford	chf	Oldsmobile	2	4	40	250	70	24	1,000	78	.....	.....	.....
	ch ho l	Pope-Hartford	5	4	70	1,250	50	82	150	....	.....	.....	.....
Portland	ch ho	Am.-La Fr. (2)	5	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	Am.-La Fr. (6)	4	4	70	1,200	40	32	....	....	.....	.....	.....
	pp ho	Am.-La Fr. (2)	4	6	100	1.200	6	32	....	....	.....	.....	.....
	ae	Am.-La France	4	4	75	....	6	177	....	....	.....	.....	.....
	tr	Am.-La Fr. (2)	1	4	70	....	...	...	....	....	.....	.....	.....
	ae	Am.-La France	1	4	70	....	...	277	....	....	.....	.....	.....
	ch ho	Am.-La France	½	4	70	1,200	40	32	....	....	.....	.....	.....
Roseburg	ch ho	Brockway	1	..	...	....	...	...	....	....	.....	.....	.....
Salem	ch ho	Am.-La France	4	4	70	1,200	40	32	....	....	.....	.....	.....
	pp ho	Am.-La France	3	6	100	1,200	40	32	....	....	.....	.....	.....
The Dalles	ch ho	Brockway	1	4	50	1,400	40	32	....	....	.....	.....	.....
Pennsylvania—													
Altoona	chf	Buick	2½	4	22	....	...	...	....	....	51.96	118.38	160.00
	ch ho l	Knox	4	6	48	800	46	20	106	99	315.96	48.04	143.25
	ch ho l	G. M. C.	1½	..	...	800	46	20	145	112	29.96	66.70	143.25
Ambler	pp	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Ashland	ch ho	Hale	..	..	...	....	...	...	....	....	.....	.....	.....
Bangor	pp ho	Am.-La France	3	6	100	1,250	6	32	....	....	.....	.....	.....
Berwick	ho	Reo-Local (2)	..	4	35	1,000	...	36	300	2	.....	.....	.....
	ch ho	Garford-La Fr.	..	4	35	500	...	36	300	2	.....	.....	.....
Bethlehem	pp ho	Am.-La France	1	4	75	1,200	6	32	....	....	.....	.....	.....
Bristol	ch ho	Am.-La France	2	4	70	1,200	70	32	....	....	.....	.....	.....
Butler	chf	Mich.	..	..	...	....	...	...	....	....	.....	.....	.....
	ch ho l	Pope-Hartford	5	4	...	1,000	45	35	75	60	.....	.....	.....
	ch ho l	Knox	4	4	...	1,000	60	32	50	45	.....	.....	.....
Carbondale	ch ho	Am.-La France	½	6	100	1,200	40	32	....	....	.....	.....	.....
Carlisle	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	.....	.....	.....
Carnegie	ch ho	Am.-La France	2	4	72	1,100	86	44	160	50	0	22.55	.....
Chambersburg	ch ho	Am.-La France	5	4	70	1,200	70	32	....	....	.....	.....	.....
Chester	tr (2)	Am.-La France	1	4	70	....	...	...	....	....	.....	.....	.....
Coaldale	pp ho	Hahn	0	4	60	1,200	...	32	....	....	.....	.....	.....
Coatesville	chf	Dodge	1-3	4	35	....	P	...	....	48	.....	.....	.....
	ladd	Am.-La France	3	4	75	....	46	279	....	....	.....	.....	.....
	pp ho ch	Am.-La France	2-3	6	90	1,000	46	32	....	....	.....	.....	.....
	ch ho l	Seagrave	1-6	4	75	1,200	76	32	....	....	.....	.....	.....
	pp ch ho	Rowe	0	6	120	....	66	32	....	....	.....	.....	.....
Connellsville	ladd	Am.-La France	¼	6	100	....	40	225	25	10	0	20.00	.....
	ch ho	Pope-Hartford	¼	4	50	600	70	...	120	20	.....	20.00	.....
	ch ho l	Pope-Hartford	4	4	60	1,000	70	48	50	60	10.00	25.00	.....
Conshohocken	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	.....	.....	.....
Charleroi	ch ho	Am.-La France	2	6	100	1,200	70	32	....	....	.....	.....	.....
Donora	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
DuQuesne	ch ho	Am.-La France	2	6	100	1,200	70	32	....	....	.....	.....	.....
Duryea	pp ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	.....	.....	.....
Easton	chf	Saxon	½	4	18	....	...	...	4,000	88	0	94.00	.....
	ho ch	Seagrave	2	6	80	1,000	70	30	400	....	0	69.80	.....
	ho ch	Seagrave	1	6	80	1,000	40	30	400	....	0	71.60	.....
	pp ch	U. S.	4	6	7	1,000	35	30	250	.....	60.00	52.20	.....
	pp ch ho	Seagrave	1	6	80	1,000	40	42	250	88	0	65.00	.....
	pp ch ho	Seagrave	0	..	...	....	...	...	....	....	.....	.....	.....
E. Stroudsburg	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	.....	.....	.....
E. Washington	ch ho	Am.-La France	2	4	70	1,200	40	32	....	....	.....	.....	.....
Edwardsville	pp	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Erie	ae	Am.-La France	2	4	72	....	6	403	300	....	30.00	31.00	540.00
	pp ho ch	Am.-La France	1-3	6	105	1,000	35	36	375	....	12.00	40.00	120.00
Franklin	pp	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	Knox	2	4	48	1,200	70	36	224	46	.....	.....	.....
	pp ho ch	Thomas	0	6	60	1,000	40	40	....	....	.....	.....	.....
Ford City	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Freedom	ch ho	Am.-La France	4	4	70	1,200	70	32	....	....	.....	.....	.....
Greensburg	ch	(2)	..	..	...	....	35	...	....	....	.....	.....	.....
Hanover	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	.....	.....	.....
Harrisburg	ch ho	Am.-La France	2	6	100	1,200	40	32	....	....	.....	.....	.....
	tr	Am.-La France	1	4	70	....	...	...	....	....	.....	.....	.....
	ch ho	Brockway	1	4	50	1,400	40	32	....	....	.....	.....	.....
Hazleton	mot	Indian	..	..	...	....	...	...	....	....	.....	.....	.....
Homestead	ch ho	Studebaker	0	4	45	600	160	40	....	....	.....	.....	.....
	ch ho l	Seagrave	3	6	85	1,200	52	110	50	89	20.00	35.00	.....
Jeannette	ch ho	Am.-La France	2	6	107	1,200	60	72	32	34	5.00	64.00	.....
Johnstown	pp ho	Am.-La France	5	..	...	....	...	...	....	....	.....	.....	.....
	pp ch	Am.-La France	4	6	100	1,200	6	32	...	....	.....	.....	.....
	pp	Am.-La France	1	6	135	1,700	40	32	....	....	.....	.....	.....
	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Kennett	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Kingston	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	.....	.....	.....
Kittanning	ch ho	Brockway	1	..	...	....	...	...	....	....	.....	.....	.....
Lancaster	ch ho	Am.-La Fr. (3)	1	..	...	....	...	...	....	....	.....	.....	.....
	tr	Am.-Ia France	1	6	100	....	6	177	....	....	.....	.....	.....
	tr	Am.-La Fr. (3)	1	4	70	....	...	...	....	....	.....	.....	.....
Lansdowne	pp ho	Am.-La France	3	4	75	1,200	6	32	....	....	.....	.....	.....
Lansford	ch ho	Am.-La France	½	6	100	1,200	40	32	....	....	.....	.....	.....
Latrobe		Has no motor apparatus.											
Lebanon	ae	Am.-La France	3	6	100	....	6	177	....	....	.....	.....	.....
	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	.....	.....	.....
Leechburg	ch ho	Brockway	1	4	50	1,400	6	32	....	....	.....	.....	.....
Lewistown	ch ho l	Thomas	2	6	60	800	60	75	....	....	.....	.....	.....
		Morton (2)	1-12	8	80	800	40	75	....	1	.....	.....	.....
Meadville	pp ho	Am.-La France	4	6	105	1,400	40	36	583	62	39.00	97.00	.....
	ch ho l	Am.-La France	2	4	75	1,000	40	32	392	40	0	27.30	.....
	ladd	Am.-La France	2	4	75	....	...	225	360	33	0	21.80	.....
Minersville	ladd	Am.-La France	2	4	70	....	...	235	....	....	.....	.....	.....
Morrisville	ch ho	Brockway	1	4	42	1,400	40	32	....	....	.....	.....	.....

(To be continued in the June number.)

Contracting News

AUTOMOBILES, MOTOR TRUCKS AND FIRE APPARATUS.

Alameda, Cal.—The city council last night authorized the police and fire commission to purchase a combination auto and fire combination auto, chemical and hose wagon with booster pump, for the department, at an estimated cost of $5,500.

Boonton, N. J.—Board of aldermen considering purchase of new motor-driven hose wagon for South Boonton fire companies.

Cass Lake, Minn.—The fire department is endeavoring to join with the village council in purchasing an automobile chemical engine.

Cherokee, Ia.—Chief Nelson, of the fire department, has presented a petition to the city council asking that a new auto fire truck be purchased.

Columbia City, Ind.—The city council is acting on its plan to motorize the city fire department and has purchased a $5,500 truck, fully equipped.

Duluth, Minn.—Station No. 2 of the Duluth fire department, at 17th ave., West, and 1st st., will be equipped with modern fire apparatus after May 1.

Elmira, N. Y.—The board of public works has purchased two motor tractors to use on dirt street work and other general hauling. They are made by the Moline Plow Co., and each one is valued at about $700.

Elgin, Tex.—At a regular meeting of the city council it was decided by a roll vote to purchase a motor fire truck for the city.

Grand Rapids, Mich.—The board of health has determined on including in its next year's appropriation a sum sufficient to purchase motor trucks for the garbage department.

Harrisburg, Pa.—City commissioners are considering petition for new fire engine for the Thirteenth ward district and new chemical wagon for the Paxton fire co. Commissioner E. Z. Gross in charge.

Jersey City, N. J.—City commissioners will build new triple fire house in Hudson City district, to cost about $50,000.

Keasbey, N. J.—Township commissioners planning for erection of new fire house and purchase of new equipment for fire district No. 4. Board of fire commissioners in charge; Wm. D. Hoy, secretary.

Kendallville, Ind.—Kendallville will take steps to motorize its fire department at once. Such was the decision of the city council.

Muskegon, Mich.—Tractors for the hook and ladder trucks of the Muskegon fire department, the second step in motorizing all vehicles of the department, are soon to be purchased by this city. Fire Chief Napoleon Beify, advising the change to motor-driven apparatus, gained the approval of the council immediately.

Oneida, N. Y.—The common council is contemplating the purchase of motor-driven fire apparatus at an estimated cost of about $8,000.

Pawtucket, R. I.—City contemplates the purchase of a motor truck at an estimated cost of $6,200.

Pitman, N. J.—Report submitted to boro council by its public safety committee, recommending purchase of new motor-driven fire equipment to cost about $6,000.

Red Wing, Minn.—The city council again considers the purchase of a street flusher.

Red Bank, N. J.—City council has authorized special election to vote bonds for the purchase of new motor-driven fire equipment, including pumping engine, hook and ladder truck, 2,500 ft. hose and other apparatus.

Salt Lake City, Utah—At a meeting of the commissioners the purchase of a fire truck was authorized. The truck will carry the fire engineer, together with 70 gallons of chemicals. The truck purchased last fall carries 240 gallons of chemicals, together with the hose and ladders.

Stevens Point, Wis.—The city council is planning to purchase a motor fire truck.

Steelton, Pa.—City council planning for the purchase of two new garbage trucks for municipal service, to cost about $5,000.

Terre Haute, Ind.—City is to have $40,000 worth of new fire equipment, which will include six new motor fire trucks. At the regular monthly meeting the common council passed an ordinance appropriating the sum to the fire force account, to be used by the department of safety in purchasing motor fire equipment.

Wauwatosa, Wis.—City is advertising for bids for the furnishing of a motor truck for the fire department.

BRIDGES.

BIDS REQUESTED.

Corydon, Ind.—Until May 10 (2 p. m.), for the construction of a bridge across Blue river, on line Harrison and Crawford counties. Sam C. Mauck, auditor.

Lawrenceburg, Ind.—Until May 8 (11 a. m.), for the construction of bridges in Clay, Kelso, Manchester and Jackson townships, six in all. Harry E. Lutherbeck, auditor.

Monticello, Ind.—Until May 8 (10 a. m.), for the construction of a bridge in White county. A. G. Fisher, auditor.

Mt. Vernon, Wash.—Until May 8, for constructing bridge over Skagit river, within city limits, 220 ft. fixed steel span, 18 ft. roadway. Estimated cost, $33,000. W. E. Costello, engineer, Mt. Vernon.

Plymouth, Ind.—Until May 8 (1:30 p. m.), for the construction of four bridges in Walnut township, one in Green township and repairs to bridges in Tippecanoe township. O. H. Weber, auditor.

Stronghurst, Ill.—Until May 27 (10 a. m.), for the construction of two reinforced concrete bridges in Raritan township, Henderson county, known as the John Simonson and John Vorhees bridges. Spans, 18 and 6 ft., roadways 20 ft. Est. of cost, $1,320 and $440, respectively. Add. Clifford Older for plans and specifications.

Visalia, Cal.—Until May 8, for the construction of nine reinforced concrete bridges, on state highway between Visalia and south county line, 96, 140, 40, 60, 32, 30, 160 and 80 ft. long. B. O. Lovelace, co. surveyor.

Wahpeton, N. D.—Until May 10 (2 p. m.), for the construction of ten or more steel bridges, according to plans and specifications on file in the office of the county auditor, F. A. Burton.

Wahpeton, N. D.—Until May 10 (3 p. m.), for the construction of two steel bridges. One across the Bois de Sioux river on section line between sections 16 and 21, and one bridge across the Red river near the section line between sections 21 and 16. Plans and specifications on file at the county auditors of Richland county, North Dakota, and Wilkin county, Minnesota. F. A. Burton, auditor Richland county, North Dakota; P. E. Truax, auditor of Wilkin county, Minnesota.

CONTRACTS AWARDED.

Beemer, Neb.—The Standard Pipe Co., of Omaha, was awarded the contract for the construction of steel bridges, steel repair work wood bridges, wood bridges repair work and concrete work.

Centralia, Wash.—Charles G. Huber, Central Bldg., Seattle, awarded contract for construction of bridge across Skookumchuck river at $14,730.

Carroll, Iowa—The Omaha Structural Steel Bridge Co., Omaha, Neb., was awarded the contract for the construction of a 270-ft. concrete deck girder, requiring about 2,300 lin. ft. piling at $15,922.

Devils Lake, N. D.—Contract for constructing eight reinforced concrete bridges was awarded to Minneapolis Bridge Co., 1129 Metropolitan Life Bldg., Minneapolis, Minn., at $8,445.

Des Moines, Iowa—The Iowa Bridge Co., Des Moines, was awarded the contract for the construction of six bridges in Black Hawk county at a contract price of $22,865.

Eureka Springs, Ark.—The International Steel & Iron Co., Evansville, Ind., awarded contract for 500-ft. steel bridge over White river and 160-ft. small steel bridge at $20,000.

Fairmont, W. Va.—The Concrete Engineering Co., New York City, awarded contract for construction of two concrete bridges here to cost about $550,000.

Macedonia, Iowa—Wickham Bridge and Pipe Co., Council Bluffs, Iowa, and Illinois Bridge and Steel Co., Jacksonville, Ill., awarded contract for bridge over the Nishnabotna river here at $12,670.

Marshalltown, Iowa—The following contracts were awarded for bridges: T. J. Wagner, Swea City, 22 bridges, $20,410; Cole Bros., Ames, Iowa, 13 bridges, $21,920; Ingersoll-Stoufer Const. Co., Marshalltown, 22 bridges, $28,665; M. O. Burnett, Marengo, Iowa, 38 bridges, $30,710.

McKenna, Wash.—Contract awarded to C. G. Huber, Central Bldg., Seattle, Wash., at $27,987 to construct concrete bridge here.

Muskegon, Mich.—N. P. Nelson, Muskepile substructure and concrete superstructure, north revetment, Ludington Harbor, Mich., at $19,499. A. M. Warner, St. Joseph, Mich., contract for similar work on north revetment of St. Joseph Harbor at $16,245.

Nevada—Contract awarded by Salt Lake & Los Angeles Ry. (J. Richards, secy. and gen. traf. mgr.) to Houghton Constr. Co., 503 Market st., San Francisco, Cal., at $90,000, to construct several reinforced concrete bridges and concrete abutments for steel bridges on its lines in this State.

Newark, N. J.—Board of Freeholders has awarded contract for bridge work as follows: Linde & Griffith Co., foot of Fourth ave., Newark, Clay st. bridge (fenders, etc.) at $18,300; Allen N. Spooner & Sons, Pier 11, North river, New York City, Paterson Plank Road bridge (new fender, etc.) at $14,650.

Olyphant, Pa.—Boland Bros., Carbondale, Pa., were low bidders for bridge over the Lackawanna river connecting Olyphant and Blakeley at $34,200.

Olympia, Wash.—Contract awarded by comrs. Piers and Thurston counties to C. C. Huber, Central Bldg., Seattle, at $27,987, to construct the McKenna bridge, of concrete; other bidders, R. E. Meith, Olympia, at $27,960, for steel; H. C. Malott, Seattle, at $28,310 for concrete; C. Barnette, Olympia, at $28,590, for steel. Anna Gaston, aud. Thurston county.

Somerset, Ky.—The Virginia Bridge and Iron Co., Roanoke, Va., has been awarded the contract for the superstructures of two steel bridges over Pitman creek and substructures have been awarded to the Builders' Supply Co., Lexington, at $14,450 and $13,035, respectively.

Sheldon, Iowa—Contract for twelve new steel bridges in the county have been awarded to the Hey-Keeler Construction Co., of Waterloo.

Seattle, Wash.—Booker, Kiehl & Whipple, Central Bldg., Seattle, awarded contract for construction of substructure for the Eastlake ave. bridge over the Lake Washington canal, at $213,000.

Washington, D. C.—Charles H. Tompkins, 1883 3rd st., N. W., Washington, D. C., awarded contract for constructing concrete bridge in the line of 16th st., northwest, crossing Military road, at $32,000.

Washington, Ia.—Contract for constructing 38 concrete box culverts was awarded by bd. of supvrs. of Washington Co., to R. H. Waugh, Clarksville, at $35,206.

Waterloo, Ia.—To the Iowa Bridge Co., Des Moines, was awarded the contract for the construction of six bridges in Blackhawk Co., at a contract price of $22,865, and to the Waterloo Construction Co., Waterloo, was awarded the contract for the construction of a foot bridge over the Cedar river, at Gilbertville.

White Plains, N. Y.—To Fagnani Bros., Tuckahoe, was awarded the contract for the construction of a stone bridge over Bronx river, between Yonkers and Tuckahoe, at their bid of $16,500.

Yonkers, N. Y.—To Fagnani Bros., Tuckahoe, for the construction of reinforced con. bridge over Bronx river, at $16,355.

CONTEMPLATED WORK.

Asheville, N. C.—Acting on the recommendation of the commissioner of public works, the city board of commissioners decided to have the city engineer prepare specifications for the construction of concrete bridges across the Cripple creek at the intersection of South French Board ave. and South Sice ave. and the intersection of Gaston st. The purchasing agent was advised to advertise for bids for this work.

Birmingham, Ala.—Bids will be called for constructing a new wooden trestle on Dervy st., in the industrial district. The bridge will be 20 ft. wide, the timbers treated and the deck covered with asphaltic concrete or something similar. It will be about a $20,000 job.

Cedar Falls, Ia.—T. Michaelson, contractor, is preparing plans and specifications for the construction of the proposed concrete bridge that will be built across Dry

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TRADE B MARK

Contracting News

run, as soon as practical, to replace the present structure.

Dayton, O.—Plans for the paving of Keowee st., from Webster st. to the corporation limits, have been completed by the county commissioners, who instructed Clerk W. H. Aszling to advertise for bids. The cost of the improvement, to be paid by both the city and county, is estimated at more than $56,000.

Des Moines, Ia.—The city council ordered plans prepared and bids received for a bridge across the Des Moines river at University ave. Estimated cost, $300,000.

Fort Smith, Ark.—City plans construction of a bridge over Arkansas river, at foot of Garrison ave. For further information address bridge comm.

Harrisburg, Pa.—Board of pub. grounds and buildings will be empowered by state legislature to plan and erect bridge over the Delaware river, between Philadelphia and Camden.

Hillsboro, N. D.—Ingwald Pedweson and Carl Arnegard, members of the board of supervisors of Bloomfield twp., appeared before the board in regard to bridge work needed in Bloomfield twp., and filed an application for such needs. Gerhard D. Olson, county auditor.

Jacksonville, Fla.—Harrington, Howard & Ash, Kansas City, are preparing plans for the construction of new concrete and steel bridges over McGirt's creek, at Ortega, and Trout creek, at Panama. The cost of the Panama and Ortega bridge is estimated at $200,000, and the bridge south of Jacksonville at about $1,000,000.

Jersey City, N. J.—Hudson and Union county boards of freeholders planning for erection of bridge over Newark bay, between Bayonne and Elizabethport. Hudson board of freeholders has voted appropriation of $5,000 for surveys.

LIGHTING.

Akron, N. Y.—State legislature passed bill authorizing $19,000 bond issue to install electric light plant and street lighting system.

Farmingdale, N. J.—Board of public utility commissioners granted permission to West Monmouth Water Co. to install and operate a system here.

Greensport, L. I.—At a special election in Deering Harbor the voters approved a bond issue in the sum of $8,500 for the lighting system.

Irving, Kans.—City plans election to vote on $7,000 bonds for distribution and lighting system and transmission line to Blue Rapids.

Jersey City, N. J.—Board of freeholders planning for installation of electric flood light projectors on bridges over Passaic and Hackensack rivers.

Quakertown, Pa.—City has purchased site for power plant and will install engine, generators, boilers, etc. G. E. Willard, supt.

Reading, Pa.—Metropolitan Electric Co. contemplates the constr. of a new transmission line from its West Reading power station to Leesport and Temple.

St. Louis, Mo.—The Central Trades and Labor Union went on record at their meeting as in favor of a municipal electric lighting plant.

Trenton, N. J.—John A. Roebling's Sons Co. will build a new power plant at its wire and wire rope factory on Canal st.

Trenton, N. J.—Stone & Webster Engineering Co. awarded contract for erection of one-story brick and concrete power plant and stack for the Westinghouse Lamp Co., at its new plant, Pennington ave., at $45,000.

Waterville, O.—Citizens want their streets lighted and contemplate the installation of street lights. A bond issue of $10,000 for the purpose will be voted on April 25.

Warsaw, Ind.—The city council of Warsaw is planning to install an ornamental street lighting system.

MUNICIPAL BONDS.

Ada, Okla.—The city will call an election soon to vote $60,000 for the purpose of improving its water supply and system. This will include constructing a new reinforced concrete flume for the water power plant and the 500,000 gallon elevated tank in the city. Benham Eginr. Co., consulting engineers; E. S. Ratliff, mayor.

Akron, O.—Ordinance No. 5403 passed for the issuance of bonds in the sum of $2,000,000 for the purpose of paying the corporation's part of improving water courses, to wit: Wolf Ledge run and tributaries thereto by constructing conduits therein. A. Cole, clerk.

Akron, O.—Ordinance No. 5391 passed to issue bonds to pay the corporation's part of improving sundry streets and to repeal ord. No. 5102 to issue bonds in the sum of $122,150 to pay the city's portion of improving sundry streets. S. J. Cole, clerk.

Bartlesville, Okla.—Washington county will shortly vote upon the question of a bond issue for the construction of a comprehensive system of hard-surfaced highways to be built in all sections of the county. It is planned to construct 121 miles of improved highways at a cost of $600,000. The proposed roads will be 16 ft. in width.

Dallas, Tex.—Finance Commissioner Manning B. Shannon announced that he will recommend to the board of city commissioners at an early date the issuance of $300,000 worth of sewer bonds voted a year ago.

Dandridge, Tenn.—The county court authorized the issuance of $200,000 road bonds; $50,000 of this will be expended in repairing old roads and $150,000 in building new roads. Archie Holsinger is a member of the road commission.

Hamlin, W. Va.—Plans have been completed by which the eight districts of the county of Lincoln will submit a road bond issue the latter part of April. The proposed issue will be $650,000, approx., and the county will be the unit in the election.

Johnson City, Tenn.—Election will be held to vote on $75,000 city hall and market house bonds. Address the mayor.

Logan, O.—An ordinance was passed to issue bonds for the purpose of improving High st. from the alley immediately north of Hunter st. to the north side of Second st., by grading, curbing and paving same with brick, in the aggregate sum of $3,400. Fred Allen, clerk.

Macon, Ga.—Members of the Bibb county road board and the county commissioners will ask the next session of the legislature to grant a special registration for a $1,000,000 bond issue proposed by the commissioners to improve the roads, build a new courthouse and to enlarge the school system.

Okemah, Okla.—The city will call an election soon for the purpose of voting $65,000 for constructing a sewer system and $20,000 for improving the electric light plant. Benham Engineering Co., consulting engr. J. B. Poynter, mayor.

Pleasant Hill, La.—Until April 24 bids will be received by W. R. Ross, secretary of board of district supervisors, Sabine parish, for $30,000 of 5 per cent. bonds, road district No. 6.

Salem, N. J.—Appropriation of $50,000 secured for new road between Sharpstown and Woodstown, on Pensgrove-Malaga section. County Engineer Keasbey in charge.

Steubenville, O.—In the county system of roads financed by the $800,000 bond issue which Brooke county approved some time ago, a road will be built from Follansbee to Eldersville, Washington county, Pa.

Union, N. J.—Town council passed ordinance providing for immediate sale of bonds for $23,000 for a fire and police signal system.

ROADS AND PAVEMENTS.

BIDS REQUESTED.

Brazil, Ind.—Until May 8 (10 a. m.), for the improvement of a highway in Washington township, in Clay county, by grading, paving with crushed stone, and draining. Add. Wm. O. Graeser, auditor.

Lewisville, O.—Until May 14, for the paving of the principal streets of the village of Lewisville. Add. Village Council.

Monticello, Ind.—Until May 8 (10 a. m.), for the improvement of two highways in White county, one in Union township and the other in Honey Creek township, by grading, draining and paving with crushed stone. Add. A. G. Fisher, auditor of White county.

Rollette, N. D.—Until May 8 (6 p. m.), for the construction of cement sidewalks and crossings on Main st. and 2nd ave. Cert. check, $100. T. W. McMilan, village clerk.

Wyndmere, N. D.—Until May 8 (2 p. m.), for the grading and construction of 10 mi. of road in said township, according to plans and specifications on file in the clerk's office. Cert. check, $100. John McDougall, clerk.

Woodsfield, O.—Until May 14, for grading, sewering, curbing and paving with hard-burned vitrified brick, Black st., in that village, Woodsfield st., Maaga st. and Railroad st. Plans and specifications at office of Ed Keylor, clerk of the village of Lewisville.

CONTRACTS AWARDED.

Battle Creek, Mich.—The Stoddard Construction Co., of Grand Rapids, have been awarded the contract for the construction of 5¾ miles of brick pavement, 18 ft. wide, at their bid of $135,297.70.

Baltimore, Md.—Paving contracts have been awarded as follows: Asphalt Block and Tile Co., for sheet asphalt paving, at its bid of $112,831.35; Lawson Construction Co., Norfolk, two annex paving contracts, at its bids of $98,689 and $57,859.50, and to P. F. Reddington, for paving with hillside blocks the hills on Mulberry and Pleasant sts., from Calvert to Courtland st., at his bid of $11,248.96.

Chillicothe, O.—Brewer, Tomlinson & Brewer, city, have the contract for the Iderea road at their bid of $73,000.

Chicago, Ill.—To John A. McGarry & Co., Security Bldg., Chicago, was awarded the contract for the paving of 95th st., from Western ave. to Keane ave., at their bid of $175,693.72.

Dayton, O.—The city of Dayton has entered into contracts with the following contractors for road improvements: Ed Ryan, for paving Jefferson st. with wood block, covering 15,524 sq. yds., at his bid of $60,572.60; E. D. Murray, for the paving of Manhattan ave., 4,675 sq. yds., at a cost of $17,233.40; Ed Ryan, for paving Grafton ave. with wood block, at a total bid of $37,079.40; W. J. Kernan, for the paving of Oxford ave. with wood block, at a bid of $11,823.85.

Forest, O.—The Forest Construction Co., of Forest, O., have the contract for building the Tenman road at their bid of $40,000.

Hamilton, O.—The Andrews Asphalt Paving Co. is the low bidder for paving the Hamilton pike in Hamilton county, at their bid of $160,000.

Lima, O.—The Andrews Asphalt Paving Co., Hamilton, which bid for seven streets of this city approximately $70,000, will be awarded the contract. They are now constructing a portable asphalt plant here preliminary to beginning the work.

Lincoln, Ill.—The Rhoades Co., city, was awarded the contract for the construction of thirteen blocks of pavement, representing a public improvement to cost $47,000.

Mercer, Cal.—J. H. Shafer, Los Angeles, was awarded the contract for the paving of K, J, O and 22nd sts., and also a number of alleys, at his bid of $56,039.

Newark, N. J.—To the Standard Bitulithic Co., 31 Clinton st., Newark, for paving the following streets, at $54,399.90: Chadwick ave., Edwin Place, Stengel ave., Norwood st., Columbia ave., Mapes Place and Telford st.

Portland, Ore.—The Warren Construction Co., Portland, for the paving of St. Helena road from Linnton to the Columbia county line, a distance of 10 mi., at their bid of $180,922.18.

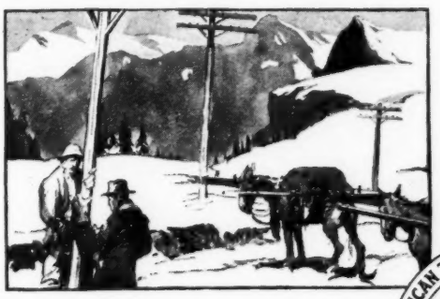
Sapulpa, Okla.—John E. Nolan, paving contractor, was awarded contracts totaling $68,727.10, for 19 blocks of paving.

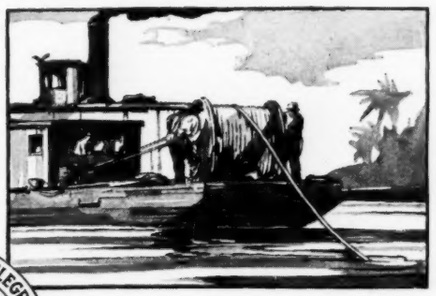
Sherman, Tex.—The Kaw Paving Co., Kansas City, was awarded the contract for the paving work on North and South Montgomery, West Pecan, East King and East Brocket sts. The work will cost approximately $50,000.

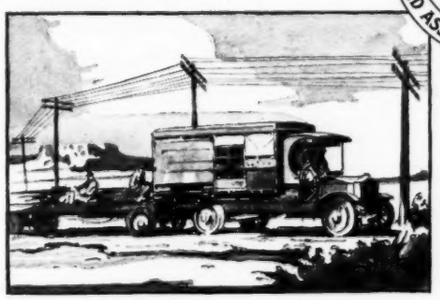
CONTEMPLATED WORK.

Atlantic City, N. J.—Board of freeholders planning for the opening and paving of Atlantic ave., through lower Margate and upper Longport, to form improved boulevard 100 ft. wide.

Atlanta, Ga.—Chief of Construction Henry L. Collier is making plans to supervise the improvement of Bellwood ave. and







AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES — LOCAL AND LONG DISTANCE TELEPHONE — BELL SYSTEM

Meeting the Universal Need

In the high passes of the mountains, accessible only to the daring pioneer and the sure-footed burro, there are telephone linemen stringing wires.

Across bays or rivers a flat-bottomed boat is used to unreel the message-bearing cables and lay them beneath the water.

Over the sand-blown, treeless desert a truck train plows its way with telephone material and supplies.

Through dense forests linemen are felling trees and cutting a swath for lines of wire-laden poles.

Vast telephone extensions are progressing simultaneously in the waste places as well as in the thickly populated communities.

These betterments are ceaseless and they are voluntary, requiring the expenditure of almost superhuman imagination, energy and large capital.

In the Bell organization, besides the army of manual toilers, there is an army of experts, including almost the entire gamut of human labors. These men, scientific and practical, are constantly inventing means for supplying the numberless new demands of the telephone using public.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

AND ASSOCIATED COMPANIES

One Policy *One System* *Universal Service*

Contracting News

of North Jackson st., both improvements being made possible by the county commission's offer of financial aid to the city.

Atlanta, Ga.—Ordinances for the paving of Willingham, from Gordon to West Hunter, of West Ontario, from Ontario to Gordon, and of 7th st., from Myrtle ave. to Penn ave., were passed on by the committee.

Bay City, Mich.—The council has been asked to arrange for the paving of 26th st. Plans and specifications are to be prepared at once and bids advertised.

Camden, N. J.—State highway commission will build road from Camden to Atlantic City, with continuation to Trenton, as part of new state road system.

Cleveland, O.—County Engineer Stinchomb states that plans for the completion of the county park blvd. will be pushed as rapidly as possible.

Fresno, Cal.—Petition for the paving of White's Bridge road from Trinity to Tohama, a distance of three blocks, was filed with the city clerk yesterday.

Garfield, Wash.—The city council has passed legislation calling for the grading of the ungraded streets in the principal part of the town and the laying of concrete sidewalks. It is estimated that the improvements will cost about $20,000, to be paid for by 10-year bonds.

Hackensack, N. J.—Board of freeholders planning for improvement with permanent paving of Ridgewood ave., from Kinderkermack road to Paramus road. Roscoe P. McClave, county engineer.

Lambertville, N. J.—Council considering plans for improvement of Coryell street with vitrified brick paving. Movement also started for construction of undergrade crossing at Ferry street and railroad tracks at estimated cost of about $130,000.

Lorain, O.—Mayor Moore is soon to appoint a city planning commission to supervise the laying out of streets, parks and allotments in order that the future development of this city may be carried out in a uniform and systematic manner.

Lincoln, Neb.—Asphalt will be used for paving Lake from 22d to Sheridan blvd., and 22d from South to Lake. Cost, $18,000. Asphaltic concrete will be used for paving 13th street from Van Dorn to High. Cost, $12,000.

Mingo, O.—Engineer Flayd is preparing plans and specifications for the paving of Union, Madison, Murdock and McLister avenues. The sidewalks on Garfield avenue are to be graded, and the sidewalk, curb and gutters are to be constructed on Western avenue. These improvements have been decided upon by council, and the ordinances are being prepared.

Newton, N. J.—Board of Freeholders planning for following paving: Construction of road from Ross' Corner to Sussex, concrete; estimated cost, $73,000. Road from Sparta to Ogdensburg, Tarvia; estimated cost, $40,000.

Newark, N. J.—Board of Works has passed ordinance providing for paving of Stuyvesant avenue and White terrace with asphalt on 6-in. concrete foundation; Division lane with oblong granite blocks, on 6-in. concrete foundation. A. L. Swain, clerk.

Newark, N. J.—Board of Works has passed ordinance for paving of Broad street, from Clay to Harvey street, with asphalt. Morris R. Sherrerd, chief engineer.

Omaha, Neb.—An ordinance has been passed by city council directing the city clerk to advertise for bids upon asphalt, stone, vitrified brick, artificial stone, macadam, creosoted wood block and asphaltic concrete for paving a number of streets. James C. Dahlman, mayor. T. J. O'Connor, city clerk.

Oakland, Cal.—Accepting the recommendation of Commission of Street William J. Baccus, the Board of Supervisors has unanimously adopted a resolution pledging the co-operation in the improvement of East Fourteenth street between Fiftieth avenue and Stanley avenue at a cost not to exceed $100,000.

Riverside, Cal.—It is proposed to pave Magnolia avenue from Jurupa avenue, where the paving now ends, to the intersection of Arlington and Palm avenues, where the other portion of the street begins. This will be done under the Vrooman act. The paving will be similar to that already completed on New Magnolia avenue.

San Diego, Cal.—City Engineer Cromwell announced that eight districts have been created for convenience in assessment in the paving of the $200,000 highway line from India street to Torrey Pines via Ocean Beach.

Sioux City, Iowa—Sixteen blocks of streets in the downtown district were ordered repaved by the city council. The council will call for bids on the work April 7th.

Springfield, Mo.—City council has been petitioned to pave 25,000 square yards on various streets with asphaltic concrete and intends constructing five miles of stone or concrete curb and gutters. O. D. Chrisman, city engineer.

Steelton, Pa.—Street Dept. planning for immediate improvement of Front street with permanent type surfacing. Jacob Meshy, street commissioner.

for the Ferry street improvement, including paving, will be about $40,000. Plans and specifications are to be prepared at once and bids advertised.

PARKS.

Akron, O.—D. K. Page announces that over $100,000 has been subscribed for developing Silver Lake and adds that the directors are going to make the park one of the most novel and beautiful parks in the State.

Cleveland, O.—City will spend $141,000 for its parks during the summer. according to Service Director Bernstein.

Grand Forks, N. D.—Charles Frederick Weller, recreational expert, Minneapolis, Minn., will have charge of construction of playgrounds in 49 communities in Grand Forks.

Newark, N. J.—Appropriation of $326,000 for Essex County Park Commission planned by Board of Freeholders. Funds to be used for road and park construction and maintenance work.

Reading, Pa.—Council planning for purchase of Pendora Park, to be improved and equipped for a public playground.

Urbana, O.—The State Legislature has appropriated $30,000 for repairs at Indian Lake Park. The improvement to be started this spring.

SEWERS.

CONTRACTS AWARDED.

Chicago, Ill.—N. D. Heiny, Gary, Ind., was awarded the contract for the construction of the big sewer at his bid of $249,222.70.

Cincinnati, O.—Two contracts for sections of Mill Creek intercepter sewer were awarded by the Board of Control. Contract No. 4, covering that portion between Mitchell and Spring Grove avenue, was awarded to D. P. Foley at his bid of $168,637.95. Welling & Franz were awarded contract No. 2, between Harrison and Marshall avenues, at $154,759.

Decatur, Ill.—To Arthur Birt was awarded the contract for the construction of the Staley-Wabash sewer at a contract price of $41,920.

Fairbury, Neb.—The Roberts Construction Co., of Lincoln, was awarded the contract for the construction of a sewer in storm and drainage district No. 1 at their bid of $11,947.50.

Gibson City, Ill.—Arthur Birt, Decatur, Ill., awarded constr. of sewer at $25,860. Contract calls for 800 ft. 20-in. tile; 1,800 ft. 18-in., 3,300 ft. 15-in., 700 ft. 14-in., 6,600 ft. 12-in., 10,000 ft. 10-in. and 9,900 ft. 8-in.

Hopkins, Minn.—To William Danforth, contractor, Germania Life Building, St. Paul, was awarded a $36,500 contract for the construction of a sewage system and disposal tank in Hopkins.

Murray, Utah—Park Bros., Salt Lake City, were awarded contract for the construction of a new sewer system at their bid of $27,000.

Newton, Iowa—The Newton city council awarded the contract for the laying of 7 miles of sewer to the Turner Co. of Des Moines. The contract for two disposal plants was awarded to Ward & Weighton, Sioux City.

CONTEMPLATED WORK.

Aberdeen, S. D.—The trunk line storm sewer system and laterals proposed is estimated to cost about $200,000.

Boonton, N. J.—Board of Aldermen negotiating with officials of Jersey City for construction of trunk sewer line. Plan proposed for city to pay $86,000 towards improvement and build a local sewerage disposal plant.

La Porte City, Iowa—The street and alley committee were authorized to construct a storm sewer on Fourth street from Walnut to Commercial street. G. E. Stebbins, clerk.

Passaic, N. J.—Board of Freeholders planning for construction of drainage system at Wesel Brook, Acquackanonck township, near the Passaic city line, including culvert and other work. Estimated cost, about $40,000.

Rhinelander, Wis.—Plans and specifications for the sewer to be built on Thayer street and Phillip street are on file with the city clerk. R. G. Robertson, city clerk.

Syracuse, N. Y.—Common council considering the installation of a sewer in Grand avenue. Estimated cost, $20,000.

SEWAGE DISPOSAL.

Chicago, Ill.—Until May 12 sealed proposals will be received by quartermaster, Fort Benjamin Harrison, Indiana, for the construction of an addition to the sewage disposal plant at said post. Information furnished on application here or to Q. M. post.

Trenton, N. J.—Colored Municipal Training School planning for installation of sewage disposal system to cost $25,000. Appropriation being arranged by Legislature.

Summit, N. J.—Board of Health arranging for the establishment of a municipal garbage collection and disposal system.

New Rochelle, N. Y.—Board of Estimate and Apportionment authorized the issuance of $15,000 in construction certificates for the purpose of constructing the first unit of the new sewage disposal works.

WATERWORKS.

Ann Arbor, Mich.—Gessner Co., Toledo, O., was awarded the contract for the laying of 16-inch cast iron water main in the city of Ann Arbor at its bid of $25,917.5.

East Troy, Wis.—City awarded the contract for putting in waterworks to J. P. Chafin for $10,000.

Greenwood, Ark.—Coal District Power Co., Lawrence, Kas., will construct waterworks system at Greenwood, Booneville, Hartford, Huntington and Mansfield, Ark.

Lancaster, O.—Service Director Geo. Larman has received a report from J. King, supt. of the city waterworks, on the proposed extension of water lines to a number of sections of the city. The total cost of the improvement contemplated will be $20,000.

Lawrenceburg, Ind.—The city council has decided to grant the Newtown Water Co. a franchise to construct a water plant in Newtown. The water company contemplates the expenditure of $32,000 on the plant

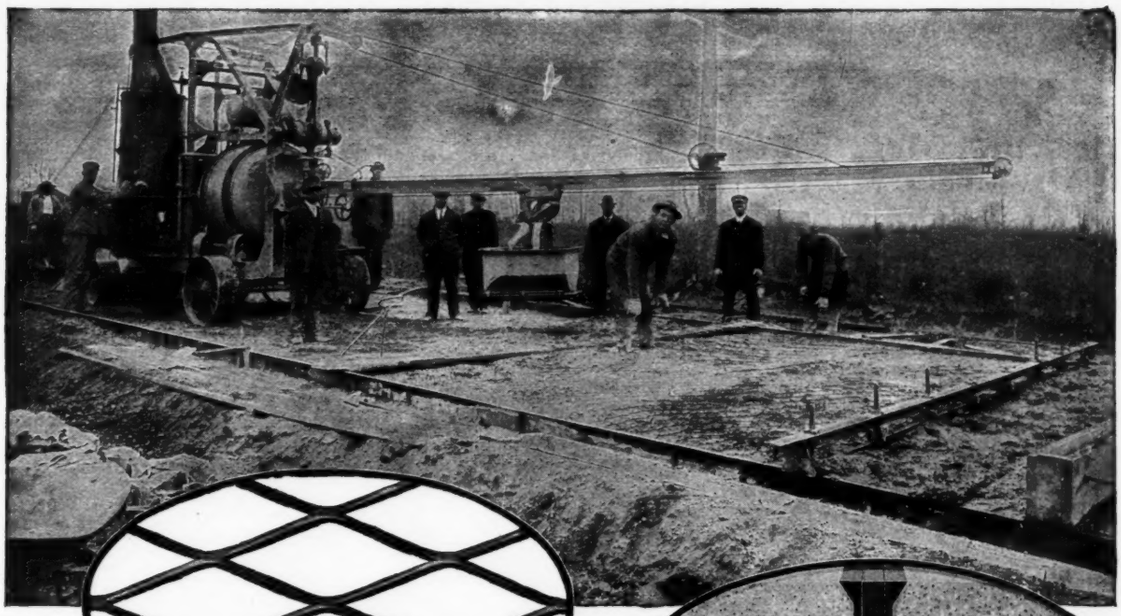
Manganese, Minn.—Bonds will be issued in sum of $10,000 for the purpose of constructing a public waterworks system in and for the village. George Phelps, village clerk.

Marshall, Mo.—The question whether Odessa shall spend $6,000 to locate water for a water plant was decided favorably last election.

Okmulgee, Okla.—The Benham Engineering Co., Colcord Bldg., Oklahoma City, will prepare plans and supervise construction of improvements to water and sewer system. Bonds for $300,000 will be voted on.

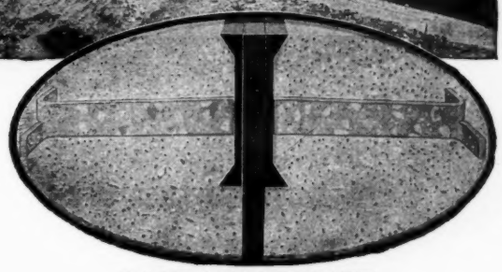
South Amboy, N. J.—Common council planning for the construction of a municipal water pumping plant for water system.

Thief River Falls, Minn.—City Engineer George Walker submitted his estimate on the cost of a new waterworks system; approximate cost, $13,000. The city clerk was ordered to advertise for bids on the contract, these to be opened at a meeting on May 8.



On the Elkhart-Goshen Highway
—Kahn Road Mesh
—Kahn Armor Plate
—Kahn Installing Device
All were used on this road.

KAHN ROAD MESH



KAHN ARMOR PLATE

For Permanence— Absolute Solidity—

Concrete must be reinforced! Steel alone can provide the tenacity—the toughness—that puts shock resistance in concrete roadways! Be certain that your concrete road is properly built through use of **Kahn Highway Products.**

KAHN ARMOR PLATES

Protect positively expansion joints in concrete roads. Manufactured of dead soft open-hearth steel of proper quality to wear down with the pavement, and yet of sufficient tenacity to withstand shocks and blows. These Armor Plates are absolute prevention against cracking and chipping of concrete at the expansion joints.

KAHN ROAD MESH

Means maximum road strength. Its steel web resists contraction and expansion in every direction. Cold-drawn from a thick sheet of steel, Kahn Mesh is shipped flat in one piece—easy to install—no tying in place necessary.

KAHN INSTALLING DEVICE

Insures proper placing of Kahn Armor Plates. This new improved device makes certain that the pavement is floated evenly with the top of the Armor Plates, and an accurate crown is insured.

KAHN CURB BARS

Are perfect protection for concrete curbs, in addition to providing a thorough reinforcement for the curb itself. These Curb Bars furnish a steel protection of 1⅝ inches, and are furnished either straight or bent. We also manufacture Kahn Edge Protectors, which follow the same principle of design as the Kahn Curb Bars except that they provide only a 1-inch protection and are generally used for the protection of columns, stairs, plastered corners, etc.

KAHN INSTALLING DEVICE

KAHN CURB BAR

Let us tell you more about Kahn-built roads and **Kahn Highway Products.** Many interest facts and illustrations in our booklet. Write for it now.

Trussed Concrete Steel Co.

KAHN Building Products — TRUSSED CONCRETE STEEL CO.

Dept. A-65. **YOUNGSTOWN, OHIO**

KAHN Building Products — TRUSSED CONCRETE STEEL CO.

Representatives in Principal Cities

Classified Dept

CLASSIFIED ADVERTISEMENTS PAY

If you are seeking employment, have second-hand machinery for sale, want to purchase machinery or supplies, want competent men to fill responsible positions, or have proposals to advertise, an ad. in these columns will put you in touch with responsible parties who can supply your wants.

RATES:

Want Ads. 1½ cents per word.
For Sale Ads. 25 cents per line.
Proposal Ads. 15 cents per line.
Minimum, 50 cents.

Rates on Display Ads. on Application.

Engineering Publishing Co.
INDIANAPOLIS, IND.

POSITION WANTED AS EASTERN REPRESENTATIVE.

Civil engineer, now selling all kinds of contractors' supplies. Owing to lack of protection, desires position as salesman. Can handle Eastern business, New York territory. Address,

H——, Municipal Engineering.

WANTED—Credit for two months' subscription to MUNICIPAL ENGINEERING or 20 cents in cash will be given to any one sending copy of any of the following back numbers to the publication office, Indianapolis, Ind., plainly marked so that the sender's name can be found:

July, 1907	September, 1911
April, 1910	October, 1911
October, 1910	October, 1912
December, 1910	December, 1915
January, 1911	April, 1916
May, 1911	

Bids received until May 14, 1917.

NOTICE TO DRAINAGE CONTRACTORS AND CONCRETE CONTRACTORS.

Notice is hereby given that Alfred Riske, engineer for the drainage district near Defiance, Mo., known as Drainage District No. 4 of St. Charles County, Misouri, will offer for sale at public outcry and receive bids, at the west door of the court house, in the city of St. Charles, Mo., at 2 o'clock p. m., on Monday, May 14, 1917, the work of clearing the right-of-way, excavating the ditch and constructing the culverts, according to plans and specifications on file in the office of the engineer, for said drainage district. The length of the ditch is 11,367.7 feet and the quantities embraced in the work are as follows:

Clearing, 1 acre.
Excavation, 9,080 cu. yds.
Culvert pipe, 18 ft. 24 in. Armco Corrugated.
Concrete, 52 cu. yds.
Steel, 5,605 lbs.
Lumber, 3,027 ft. white oak.

Bids will be taken separately for clearing and excavation and for the culvert work. All work to be completed on or before the first day of December, 1917. A bond, payable to the State of Missouri, of 20 per cent. of the amount of the bid will be required, signed either by two local qualified bondsmen or by a surety company authorized to transact business in the State of Missouri.

For further information apply at the office of the engineer, Room 6, First National Bank Building, St. Charles, Mo.

H. C. SANDFORT,
Clerk of the County Court of St. Charles County, Missouri.

Bids received until May 26, 1917.

NOTICE TO CONTRACTORS.

The board of supervisors of Road District No. 8 of Rapides Parish, Louisiana, will receive sealed bids up to 12 m. of Saturday, May 26, 1917, for the grading, bridging, culverts and drains; for the hauling, placing and rolling of the gravel surface; for the gravel, sand, stone, reinforcement and bridge material, required for the construction of Units 1, 2 and 3 of the highways to be improved in Road District No. 8, aggregating approximately 15 miles; all in accordance with certain plans and specifications on file in the office of Ira W. Sylvester, engineer, Alexandria, La.

Bids will be accompanied by certified check in the amount of 5 per cent. of the price bid, made payable to J. W. Texada, president board of supervisors, Road District No. 8.

The right to reject any and all bids is reserved.

All bids will be opened and considered in the police jury room of the parish court house, Alexandria, La., at 12 m. of Saturday, May 26, 1917.

For further information address J. W. TEXADA, Pres. Bd. of Supervisors, Road Dist. No. 8, Boyce, La.

IRA W. SYLVESTER, Engr.,
Alexandria, La.

Bids received until May 16, 1917.

STREET PAVING.

Sealed bids will be received by the city clerk of the city of Eldon, Ia., up to 7:00 o'clock p. m., Wednesday, May 16, for grading, curbing and paving nine blocks or approximately 13,000 sq. yds. of pavement, 1,500 yds. extra excavation and 6,700 ft. of concrete curb.

Bids will be received on vitrified brick and brick block, concrete, asphaltic concrete and Warren Bros. bitulithic, laid on concrete foundation.

Certified check to the amount of 5 per cent. of bid must accompany proposal in separate envelope, which will be returned to unsuccessful bidders. Successful bidder must enter into contract within ten days after award of contract and must furnish bond to the amount of 50 per cent. of contract price for the faithful performance of the work, and to guarantee the pavement for a period of five years after acceptance.

The bids must be on blanks furnished by the city, and the right is reserved to reject any or all bids.

Plans and specifications may be seen at the office of the city clerk, Eldon, Ia.

H. E. RITZ, City Clerk.

MOTOR FIRE APPARATUS.
BORO OF CLIFFSIDE PARK, BERGEN COUNTY, N. J.

Bids open May 14, 1917.

Notice is hereby given that the mayor and council of the boro of Cliffside Park, Bergen County, New Jersey, will receive sealed bids at a regular meeting to be held at the Boro Hall, corner of Palisade anl Jersey avenues, on Monday evening, May 14, 1917, at 8 o'clock, for the following fire apparatus, detailed specifications of which are now on file in the office of the boro clerk:

To convert a horse-drawn hose wagon, now at the Grantwood hose company's fire station, to a motor-driven combination hose and chemical truck.

Bids for a complete new equipment, with due allowance for the above-mentioned horse-drawn hose wagon will also be considered.

No bids will be received before the hour of 8 p. m. and none after 8:30 p. m.

The mayor and council reserve the right to reject any or all bids.

Dated April 17, 1917.

LOUIS J. RENTLER, Boro Clerk.

MOTOR FIRE APPARATUS.
BORO OF CLIFFSIDE PARK, BERGEN COUNTY, N. J.

Bids open May 14, 1917.

NOTICE TO BUILDERS OF MOTOR FIRE APPARATUS.

Notice is hereby given that the mayor and council of the boro of Cliffside Park, Bergen County, New Jersey, will receive sealed bids at a regular meeting to be held at the Boro Hall, corner of Palisade and Jersey avenues, on Monday evening, May 14, 1917, at 8 o'clock, for the following fire apparatus:

One quadruple combination motor fire apparatus, together with all necessary attachments, according to detailed specifications now on file in the office of the boro clerk.

Equipment to consist of a pumping engine with a capacity of at least 500 gallons at 120 pounds net pressure, chemical tank, hose body, and approximately 140 ft. of ladders.

Motor to be 75-h.p., A. L. A. M. formula. Wheels to be Sewell cushion wheels.

Bids from manufacturers of motor fire apparatus only will be accepted.

No bids will be received before the hour of 8 p. m. and none after 8:30 p. m.

The mayor and council reserve the right to reject any and all bids.

Dated April 17, 1917.

LOUIS J. RENTLER, Boro Clerk.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of MUNICIPAL ENGINEERING, published monthly at Indianapolis, Indiana, for April 1, 1917.

State of Indiana, County of Marion, ss:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Charles C. Brown, who, having been duly sworn according to law, deposes and says that he is the Editor and Manager of the MUNICIPAL ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, Engineering Publishing Company, Inc., Indianapolis, Indiana; Editor, Charles C. Brown, Chicago, Illinois; Managing Editor, Charles C. Brown, Chicago, Illinois; Business Manager, Charles C. Brown, Chicago, Illinois.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent. or more of the total amount of stock): Engineering Publishing Company, Inc., Indianapolis, Indiana; A. P. Fox, Indianapolis, Indiana; Charles C. Brown, Chicago, Illinois; C. S. Sale, Urbana, Illinois.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.) Frank S. Stalnaker, trustee, Indianapolis, Indiana, for A. P. Fox, Indianapolis, Indiana, and Charles C. Brown, Chicago, Illinois.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHAS. C. BROWN,
Editor and Manager.

Sworn to and subscribed before me this 30th day of March, 1917.

(SEAL) VIOLA HEDRICK.

(My commission expires March 1, 1920.)

MOTOR TRUCK OPERATION AND ACCOUNTING XXI.

By Charles A. Dickens.

Because they can be kept constantly on the move and can be operated at almost any speed desired, the motor truck is especially well adapted to the work of street sweeping and flushing. The fact that the power of the engine can also be applied to the pumps or other necessary machinery is also a decided point in their favor. So many are the marked advantages of the motor truck in this work over horse-drawn apparatus that their use is rapidly extending thruout the live municipalities of the United States.

In many cases the chassis is used for different purposes at different seasons of the year, making the truck more than ever always on the go, an all-year proposition. Witness the changeable body truck in use by the city of Boston, Mass.

"Old Versatile" Does Varied Work.

"Old Versatile" is the name of the Peerless 5-ton motor snow plow that has earned its price many times over during the five years it has been in operation over the streets of Boston. During its career it has performed a wide variety of useful purposes. In fact, in behalf of "Old Versatile" we are prepared to issue a challenge to any other truck in municipal service to excel this Bostonian record.

Originally employed as a regular carrier of stone and road-building material, its removable body was displaced by a tank. This tank, in connection with a power pump, was used during the spring and summer season as a tree-sprayer, water sprinkler and to spray oil on dust-covered highways. It was also pressed into service as an auxiliary to the fire department. The force of the pump is sufficient to throw a stream to extinguish small brush fires along the road.

Again, as a refuse truck with a dump body, it can transport with ease 100 barrels of waste. (Four double teams would originally have been necessary.) It has been used as a refuse collector and a snow plow. The boards in front were so connected on this latter device that it was but the work of an instant to elevate them and send the truck to do duty in any section of the city.

Portland Cuts Sprinkling Costs.

In Portland, Ore., a motor-driven sprinkler has cut in two the cost of street cleaning. This truck, a 5-ton Locomobile, carries a 1,300-gallon tank. Water is forced onto the pavement under a pressure of 50 pounds, by a centrifugal pump driven from the automobile engine.

Portland has 370 miles of paved streets, with 20,800 square yards to the mile. This motor sprinkler will cover 6 miles a day at a cost of $17.27 as against a daily cost of $38.60 recorded for the old horse sweepers which covered the same area. This saving in cost for a year of 300 days totals $6,426, or the approximate initial cost of the truck.

Street Flushing In Niagara Falls.

The city of Niagara Falls is very successfully operating a 1,200-gallon motor-driven tank in the work of street flushing.

G M C 5-TON FLUSHER AS OPERATED BY THE BARRETT CO., FALLS, N. Y.

G. V. 3½-TON FLUSHER AS OPERATED BY CITY OF BOSTON, MASS.

GRAMM-BERNSTEIN 5-TON FLUSHER AS OPERATED BY CITY OF YOUNGSTOWN, O.

MORELAND 5-TON FLUSHER AS OPERATED BY CITY OF LOS ANGELES, CAL.

STERLING 5-TON OILER AS OPERATED BY CITY OF MIWAUKEE, WIS.

KELLY 3½-TON OILER AS OPERATED BY BARRETT MFG. CO., CHICAGO, ILL.

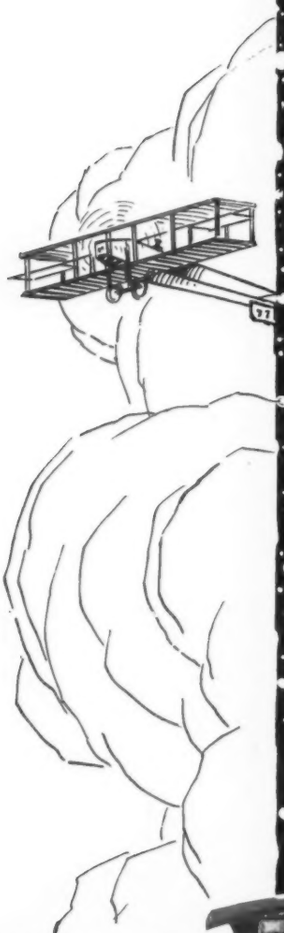
MENOMINEE 3½-TON SNOW PLOW AS OPERATED BY SUPERIOR, WIS.

GARFORD 5-TON SNOW PLOW AS OPERATED BY WASHINGTON BULKLEY, INC., BROOKLYN, N. Y.

KELLY 3½-TON SNOW PLOW AS OPERATED BY SOUTH PARK COMMISSIONERS, CHICAGO.

HURLBURT

THE PIONEER 6 CYL WORM-DRIVEN TRUCK



Balance! Perfect in the HURLBURT! Developed to a point where it *saves dollars* on operation—on upkeep!

HURLBURT sixes are balanced when *loaded*—balanced when *empty*—and at all the *"in-between"* points. The *big* load is all carried on heavy rear springs.

HURLBURT loads are carried at *top notch* efficiency. Weight (correctly distributed) holds truck down—even on rough roads.

Less side-skids! Less power lost through spinning wheels. Less racking, too—and *longer truck life!*

Loaded (or unloaded) the HURLBURT takes hills without traction loss! That's where HURLBURT balance and smooth running cuts haulage costs. *Saves money.*

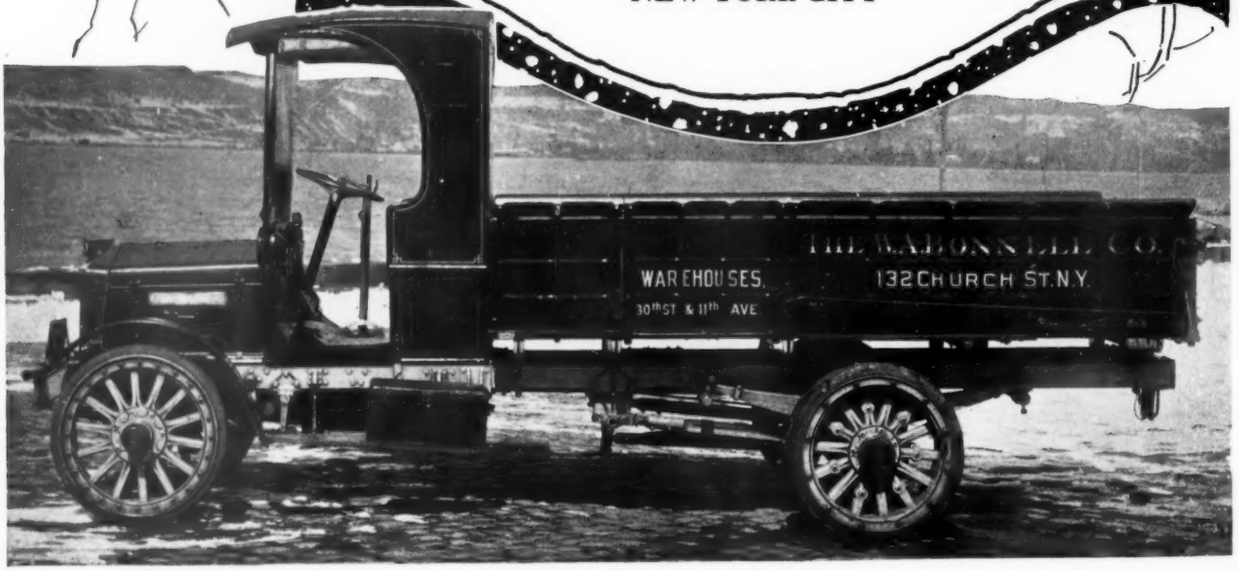
Lighter front springs protect engine and steering gear! *Increased operating safety* for HURLBURT owners! And guaranteed for the life of the truck.

Just a few reasons why HURLBURT sales increase *500% per annum!* And don't forget the Steady Six-Cylinder pull and the HURLBURT 50,000-mile *guaranteed* worm gear.

HURLBURT SILENCE IS GOLDEN

Hurlburt Motor Truck Co.

THIRD AVENUE AND HARLEM RIVER
NEW YORK CITY



This piece of equipment is illustrated in these pages. The tank is mounted on a 5-ton G. M. C. chassis and four flushing nozzles controlled by levers in convenient reach of the driver project the water onto the roadway.

Power for flushing is supplied by a centrifugal pump driven by a silent chain from the power-take-off shaft extending thru the rear-end transmission case. This flusher will supply water at the rate of about 350 gallons per minute at 35 pounds pressure.

Garbage Collection In New York City.

"Different from the street cleaning equipment used by any other city," states the *Scientific American*, "the twelve motor tractor-and-trailer units now employed in the model street-cleaning district of New York City, under the supervision of Commissioner Fetherston, are designed to do all the work in that district, including the collection of garbage, ashes and paper refuse in the day, the sweeping and flushing of the streets at night, and the cleaning off of snow in winter. Aside from the multifarious work which they are designed to do and the elimination of all horse-drawn vehicles in the area in which they work, the tractors are featured by the use of gas-electric drive and by the fact that they haul huge 20-ton detachable trailers."

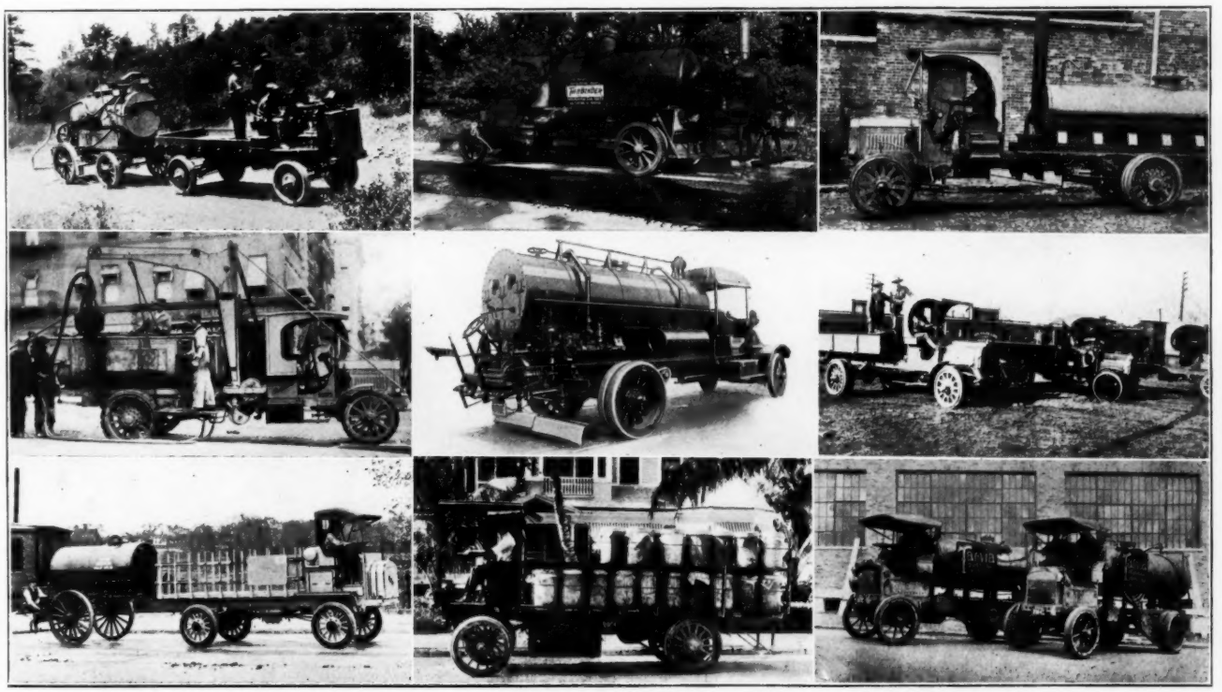
REASONS FOR GAS-ELECTRIC TYPE.

The selection of the gas-electric type of drive on the tractors was made for cheapness and operating simplicity. While the electric tractor was highly desirable from the standpoint of ease of operation, the fact that each unit has to work 16 out of the 24 hours every day made its use impossible except by the employment of two sets of batteries, because of the mileage limitations imposed upon it by the storage battery equipment. On the other hand, the gasoline tractor with gear transmission, clutch and spark and throttle controls, was impracticable because of the great number of stops in collection work, averaging from 60 to 100 per hour, and the subsequent slow acceleration between stops, the comparatively large consumption of gasoline during these periods, and the resulting necessity for drivers of a higher class.

The gas-electric type of drive, comprising a gasoline motor directly connected to an electric generator whose output is used in motors driving the rear wheels, combines the desirable qualities of both the purely gasoline and the purely electric tractor. The mileage limitation of the latter is overcome thru the generation of the current by means of a gasoline motor instead of being taken from the storage battery. The simplicity of the electric is retained thru the elimination of the gear shift and the conventional controls of the gasoline tractor, while the comparatively large gasoline consumption of the latter, when the motor is run at normal speed during the many short stops, is eliminated by the use of a special device which automatically cuts the speed of the motor in half when there is no load on the generator.

DESIGN OF TRACTORS AND TRAILERS.

The governor device consists of a solenoid of the plunger type, which is connected in the throttle lever of the gasoline motor by linkage. It is wired in multiple across the generator terminal thru a contactor on the driver's controller shaft, which in turn is so arranged that a slight movement of the controller handle from neutral position in either direction will close the circuit, automatically speeding up the gasoline engine before the driving motors at the rear wheels begin to draw current. Conversely, throwing the controller to neutral automatically reduces the gasoline motor speed to half that when there is a load on the generator.



JEFFERY QUAD TAR DISTRIBUTOR AS OPERATED BY CALIFORNIA STATE HIGHWAY COMMISSION.

PACKARD 5-TON CATCH BASIN CLEANER OPERATED BY BORO OF MANHATTAN, NEW YORK.

F. W. D. 3½-TON TRUCK PULLING OILER AS OPERATED BY LA CROSSE COUNTY, WIS.

G. V. 6-TON MERCEDES TAR DISTRIBUTOR AS OPERATED BY HAHESY BROS., CHELSEA, MASS.

KELLY 3½-TON ROAD OILER AS OPERATED BY CITY OF OMAHA, NEB.

G. V. 2-TON ELECTRIC GARBAGE TRUCK AS OPERATED BY CITY OF MIAMI, FLA.

PACKARD 5-TON TAR DISTRIBUTOR AS OPERATED BY BARRETT MFG. CO., CINCINNATI, O.

U. S. 5-TON TRUCKS AS OPERATED BY KENTUCKY STATE MILITIA.

LOCOMOBILE 5-TON TAR DISTRIBUTOR AS OPERATED BY BARRETT MFG. CO., NEW YORK CITY.

FEDERAL MOTOR TRUCK COMPANY

MANUFACTURERS OF

FEDERAL
MOTOR TRUCKS

REPLY TO ATTENTION OF

DETROIT MICHIGAN U.S.A. May 1, 1917.

Mr. M. L. Pulcher

Federal Motor Truck Company,
Newark, N. J.

Attention: Mr. George Ludlum.

Dear George:

Everything comes to him who waits. You've been looking forward to the complete FEDERAL line. Now it's ready - FEDERAL quality in every needed capacity.

We are going to make announcement of all five models in May - One Ton, One and a Half Ton, Two, Three and a Half, and Five Ton models.

The photo prints I enclose will give you a good idea of the jobs themselves. I think they're corkers. How do they look to you?

Remember -- these are not "new" models in the sense of being revolutionary departures from past FEDERALS. All the stamina and reliability of the good old FEDERAL has gone into these models -

- in addition, they have everything that motor truck experience has taught us right down to May 1st, 1917.

This line of FEDERAL trucks is, in essence, the outgrowth of seven years spent in studying the haulage needs of Business.

Features? Every point of FEDERAL construction is a "feature" in the sense that it was designed solely with haulage service in mind.

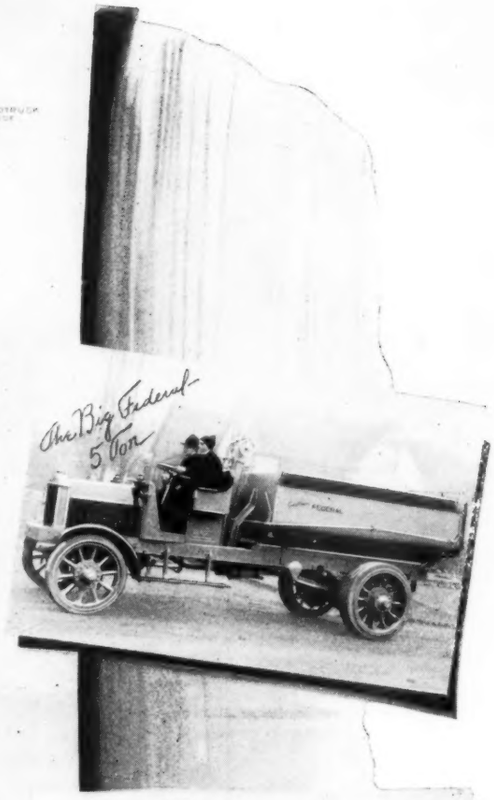
The engine is a truck engine exclusively -- "full of pep". The oiling system, by means of pump pressure, increases lubrication as heavy duty or increased speed make it necessary - and so on -

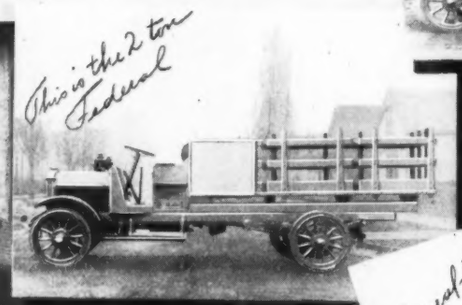
I can't hope to cover all the points here, of course. You have them all in the "Blue Print Book". We are receiving quite a number of inquiries for these. Do not fail to get a supply for distribution.

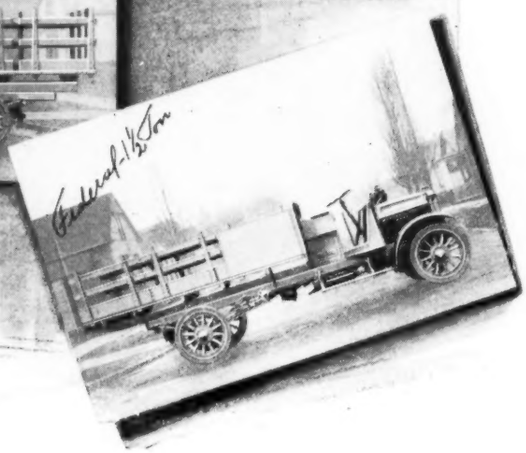
Now then, here's hoping for the best year yet! I know that this FEDERAL family is going to prove well worthy of its name.

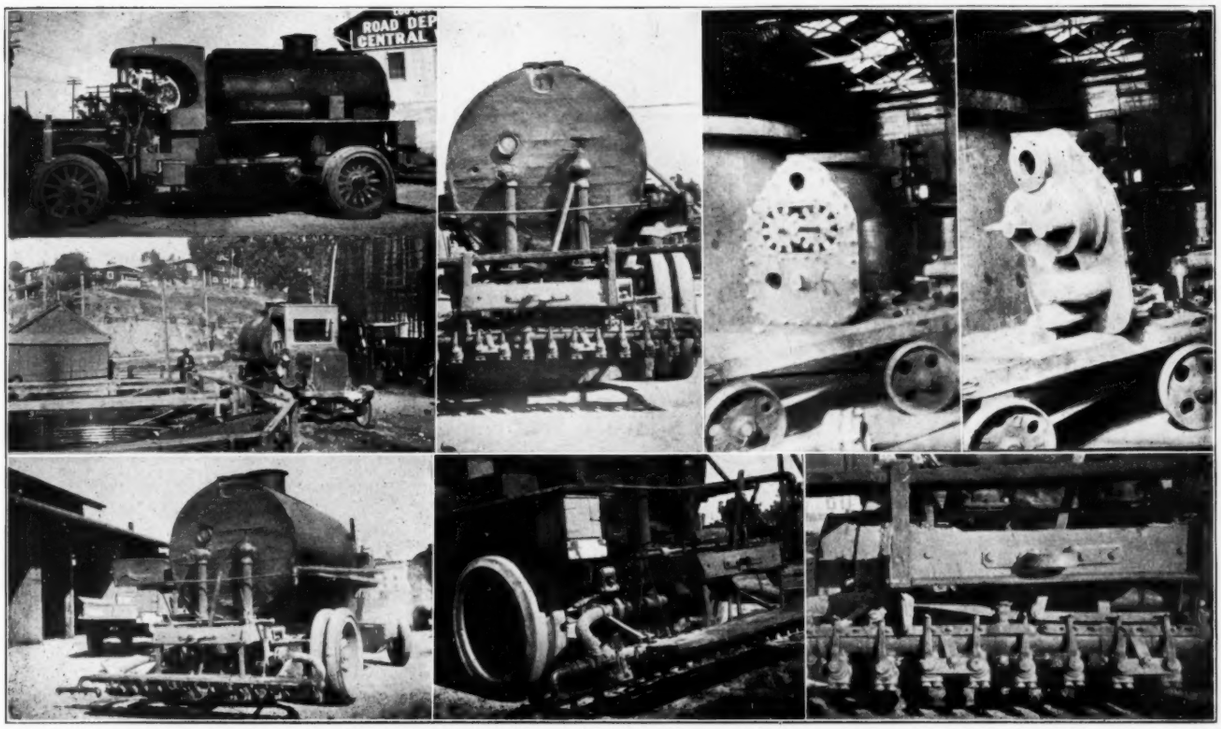
Yours with best wishes,

M. L. Pulcher
Vice President
FEDERAL MOTOR TRUCK COMPANY









PEERLESS 5-TON ROAD OILER AS OPERATED BY LOS ANGELES COUNTY, CAL. VIEWS SHOWING OIL TANK LOADING WITH OWN POWER FROM TANK IN GROUND. REAR VIEW SHOWING EXTENSION, VALVES AND GAGES. FRONT VIEW OF PUMP CASTING SHOWING ROLLERS. REAR VIEW OF PUMP CASTING. VIEW SHOWING EXTENSION AND STEP FOR OPERATOR. DETAIL OF HEADER.

The solenoid device is locked to be tamper-proof. From the moment the gasoline motor is started at the beginning of the day's work, it is kept running without any attention on the part of the driver, its speed being regulated by the solenoid apparatus. All the driver has to do is to steer the vehicle and operate the controller, which gives five speeds forward and two reverse.

Perhaps of equal importance with the design of the tractors is that of the trailers for the collection of garbage, ashes and paper refuse at the same time. The trailers make use of eight double-decked steel buckets. The lower buckets are arranged in two longitudinal rows of four each, set into the trailer frame. On top of these are two other buckets with V-shaped bottoms and side dors. The latter are opened to permit the men to dump the cans of garbage or ashes into the eight buckets on the lower deck, the paper and other refuse collected being thrown directly into the upper buckets from the sidewalk.

In unloading at the disposal pier the upper buckets are lifted off first, dumped into scows and then set down on the pier floor. Then each of the lower buckets is hoisted out and dumped in a similar manner. They are then loaded onto the trailer in the reverse manner, when the unit is ready to return to its next point of collection.

The sweeping and flushing on the streets and the plowing of snow in the winter is to be done by special trailers. The tractors were used to plow snow after last winter's heavy snowstorms, however, by uncoupling the trailers and applying the conventional front-end plows.

Largest Motor-Driven Flusher.

What is probably the largest motor-driven flusher of its kind has been put in service by Mr. F. H. Clark, Superintendent of Streets and Engineering, of Springfield, Mass. The equipment consists of a Knox Model-35 Tractor, used in connection with a Hvass street-flushing trailer.

The pump, which is mounted on the tractor, is capable of discharging 350 gallons of water per minute at 35 lb. pressure. This pump is part of the flushing equipment and is driven by a special power-take-off. Flusher nozzles are all placed on the tractor, one in front of each wheel. Sprinkler-heads immediately in front of the front wheels are fed from the same line of pipe as the flusher-nozzles and controlled by a three-way cock so as to permit the water to flow either to the sprinkler-heads or flusher-heads, as may be desired.

The four flusher-nozzles and two sprinkler-heads are all controlled from the driver's seat with snap levers, all immediately in front of the operator. One operator works the entire outfit, altho the probabilities are in some instances two may be preferred.

The pump is of the centrifugal type of special design. The tank contains 1,700 gallons. It is 48 inches in diameter, 18 feet long and made of 3/16-in. shell and ¼-in. heads. The tank contains swash plates. The frame is of 8-in. channel with 8-in. I-beam cross members. The connection from tank to pump is of special construction allowing sufficient flexibility for control to turn in any direction. Special fitting, of course, is required for pump connection. There is plenty of clearance between trailer and tractor. The trailer is mounted on silicon manganese steel springs with patented Archibald bronzed bushed axles. Wheels have 10 by 1¼-in. steel tires, dual type. Axles are 4-in. size.

Great economy is claimed for this method of street flushing, inasmuch as by having the increased capacity of the tank too frequent stops are eliminated. Owing to the short turning radius of the tractor and trailer, it may readily be turned around in the narrowest of streets, thus eliminating the lost time necessitated by the conventional type of motor truck being forced to go to the end of the street for turning purposes. The bulk of the load is also being carried on the steel-shod tires of the trailer wheels. One of the great advantages claimed for this method of street flushing is that when winter sets in the tractor may be detached from the street-

Gilroy's Halls Haul on Schedule!

Right on the *dot* at the *job* with the *stuff!* In and out of the Broadway traffic tangles—through hindering tie-ups, with a short stop and a quick pickup that makes much of every minute! That's the reputation the HALL has gained with the Gilroy Contracting Co., of New York City. And with Gilroy *minutes* mean *dollars!!*

When they get to the job Gilroy's HALLS hardly stop to unload. In less than a minute the engine-driven automatic hoist-tilted body slides the load off in *one clean sweep.* Body returns of itself to a horizontal position.

Just one case, but it illustrates the *special* adaptability of the giant HALL to *contracting* work. HALLS speed up results and cuts down contracting load-carrying costs because they are built for *emergencies* and walk off easily with the unusual demand.

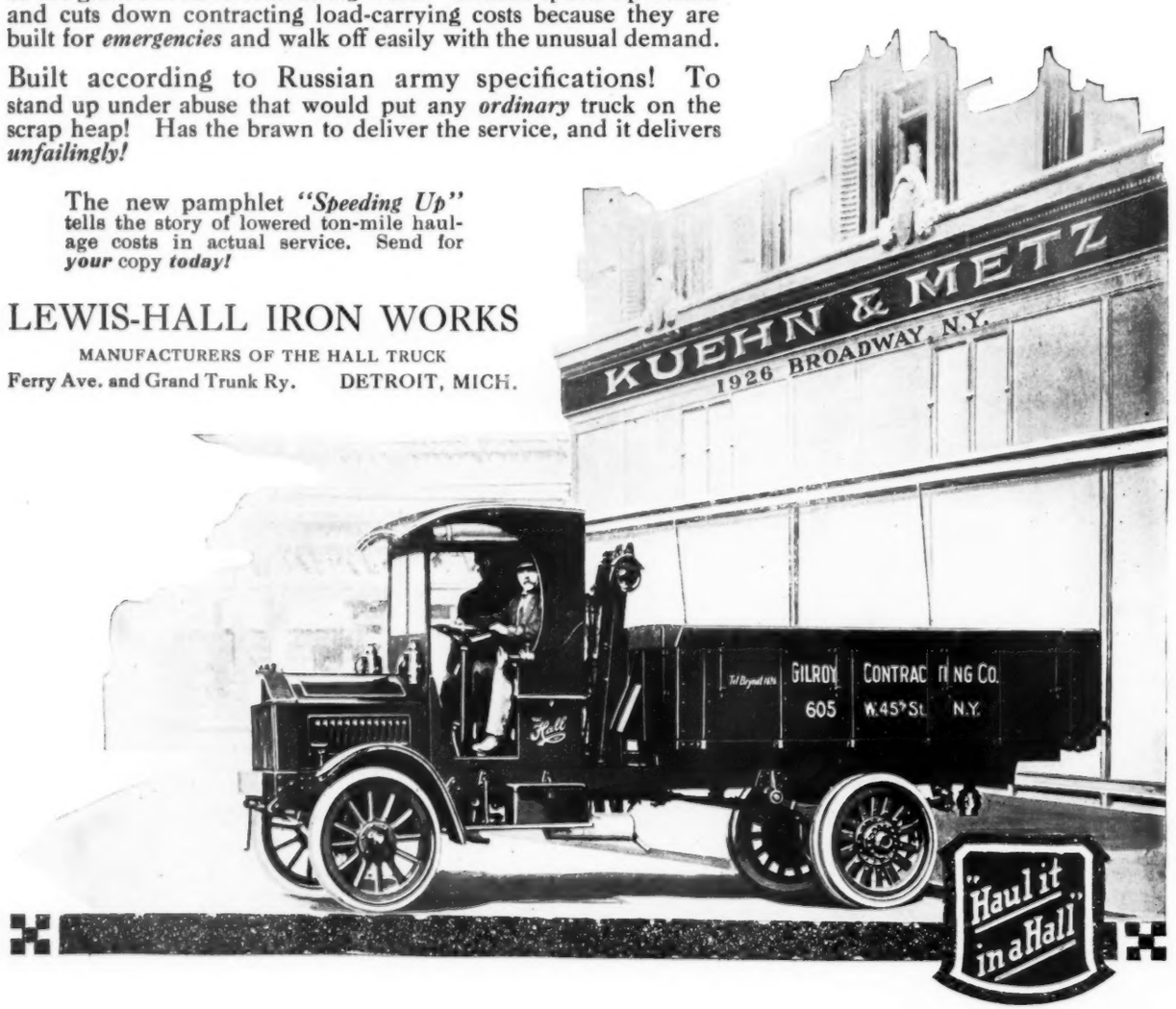
Built according to Russian army specifications! To stand up under abuse that would put any *ordinary* truck on the scrap heap! Has the brawn to deliver the service, and it delivers *unfailingly!*

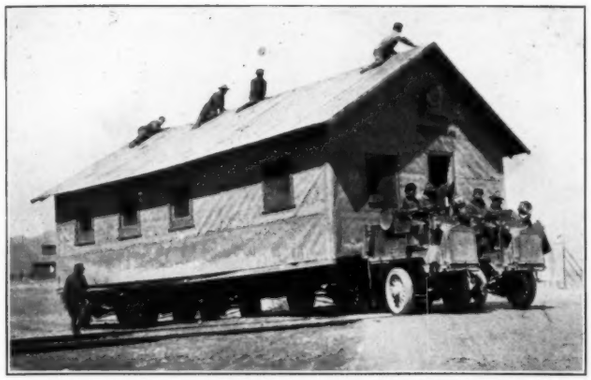
The new pamphlet *"Speeding Up"* tells the story of lowered ton-mile haulage costs in actual service. Send for *your* copy *today!*

LEWIS-HALL IRON WORKS

MANUFACTURERS OF THE HALL TRUCK

Ferry Ave. and Grand Trunk Ry. DETROIT, MICH.





FOUR F. W. D. TRUCKS AS OPERATED TO MOVE NATIONAL GUARD COMPANY HOUSE DISTANCE OF 7½ MILES AT CAMP STEWART ON MEXICAN BORDER.

flushing trailer and used in connection with dump trailers, if desired, or for hauling garbage. By this means, the tractor can be kept constantly busy earning money for the city. The tractor which is illustrated in this issue has brought considerably increased economy to the department it serves, having replaced five horse-drawn vehicles.

Electrics Flush Boston's Streets.

In this issue is illustrated one of five 3½-ton G. V. Electric combination flushers and sprinklers operated by a contractor for the city of Boston, Mass. The tanks carried on these trucks have a capacity of 800 gallons each. In winter these electrics are put to work at waste removal. A time-saving feature of these machines is their patent battery cradle which lowers the batteries when needed for a big day's work. Fresh battery can be installed in about five minutes.

Motor Truck Costs In Seattle.

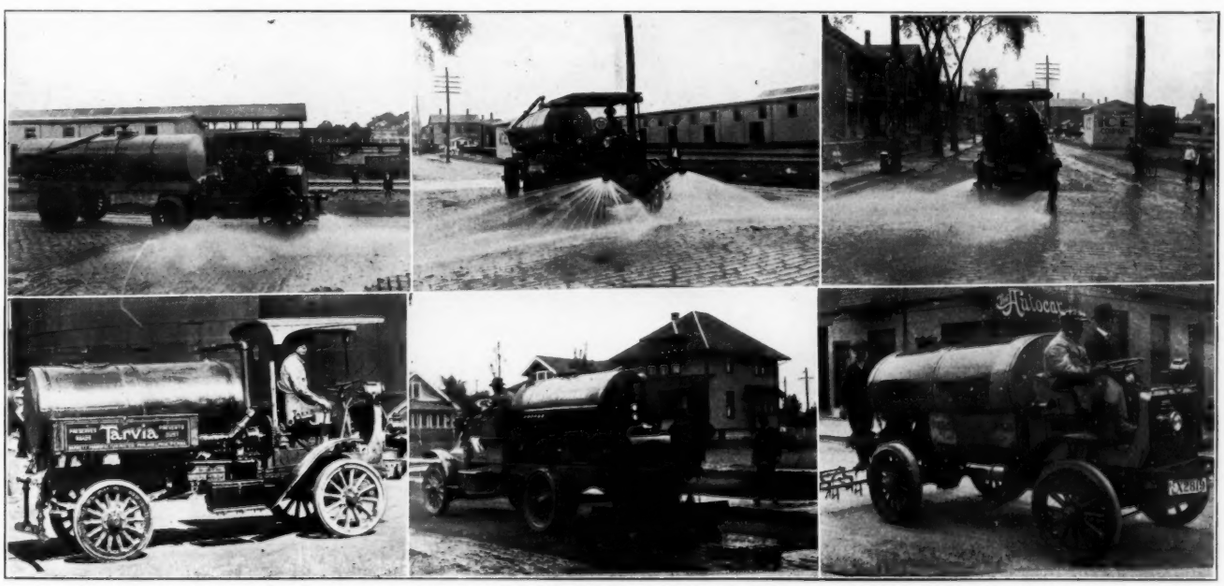
Figures compiled by the Department of Streets and Sewers, Seattle, Wash., show that a considerable saving was made over the cost of doing an equal amount of work with horse-drawn wagons. A 1-ton Velie and three 3-ton Gramms were used in the work. Each one of the three-ton trucks regularly did the work of three or four teams, carrying on the average a load

ONE OF SEVEN 4-TON MORELAND TRUCKS AS OPERATED ON ROAD MAINTENANCE BY LOS ANGELES COUNTY, CAL.

of 26 tons a distance of 30 miles. For this work the cost per truck was $7.90. The cost per day for the 1-ton truck was $7.80 and its cost per mile slightly under 26 cents. Cost per mile for the 3-ton trucks averaged 29 cents.

Oiling and Utility Truck.

A special oil-truck design has been worked out by Los Angeles County, California, for use in both road oiling and road maintenance work. It is so arranged that the oil tank and header may be removed, and a flat body or dump body



KNOX MODEL NO. 35 FOUR-WHEEL TRACTOR (PULLING HVASS STREET FLUSHING TRAILER) AS OPERATED BY THE CITY OF SPRINGFIELD, MASS. AUTOCAR TAR DISTRIBUTOR AS OPERATED BY THE BARRETT CO., PHILADELPHIA, PA. KELLY ROAD OILER AS OPERATED BY DEPARTMENT OF PARKS, CITY OF OMAHA, NEB. AUTOCAR OILER AS OPERATED BY DANIELS ROAD OILING CO., PROVIDENCE, R. I.

Gramm-Bernstein Trucks

have long stroke, small bore motors which save fuel and give more power.

Many trucks use motors primarily designed for pleasure cars and simply built heavier for truck use. In actual service this is just about as practical as fattening up a race horse for heavy draft work.

G-B motors are designed especially for heavy hauling and not speedway contests. The governor—which is built in the motor and not added as an afterthought—is so set that the peak of greatest pulling power is well **inside** the governed speed. This is not true with trucks using motors made by pleasure car engine builders, and that's why you will find the "foxy" drivers, who want their engines to develop enough "pull" to get them out of tough places, take the governors off which soon results in all the troubles that develop from over-speeding.

In fact, the motors used in all six G-B truck models are the **only type that actually do better work with a governor than without one.**

And the motor is only one point of superiority—every other feature of G-B trucks will stand the same comparison. For instance there's the famous G-B constant mesh **transmission,** the **springs** and the **radiator** which are **all guaranteed for the entire life of the truck.** You'll appreciate this better when you ask other manufacturers what guarantee they give.

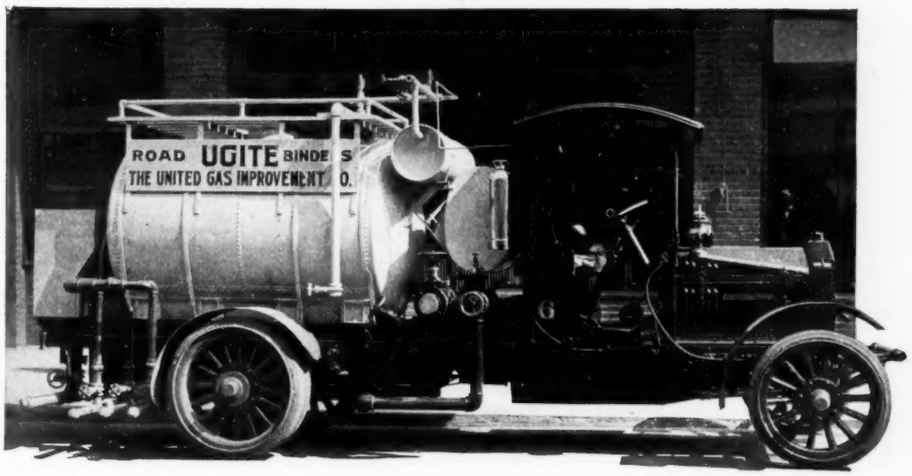
Send for our handsome, large, 32-page catalog, and you'll understand why we say "You can't afford to buy **any** truck until you have investigated the G-B."

Gramm-Bernstein Motor Truck Co.
LIMA, OHIO.

Manufacturers of high grade worm-drive trucks, 1 to 6 tons

"It's the man-or th' machine -wid th' kick-th' punch-th' power, that gits there"

Transmission Tim



PIERCE-ARROW AS OPERATED BY THE UNITED GAS IMPROVEMENT CO., PHILADELPHIA, PA., IN DISTRIBUTION OF ROAD OILS.

be put on in place of it, thus keeping the truck busy all the time. The truck, which is illustrated in this issue, will handle any material up to asphaltic cement, retaining its heat all day, and be ready at any moment to cover a patch from 6 inches square to 8 feet wide (12 feet with extensions on header) of any length, and of any amount up to about 1½ gallons per square yard.

In order to make the heat of the entire body of oil available to keep everything hot right down to the nozzles which spray the oil on the road, the pump was placed in the front head of the tank, and all the piping outside the tank is arranged so that oil can be circulated thru it until it is at a working temperature.

The pump is driven by chain from a shaft extending thru the front of the transmission. By building a three-way cock into the body of the pump casting just underneath the runners, the pump can be shut off and taken apart with the tank full of oil, and at the same time the cock makes available a side outlet in the suction that can be connected either to the pump or to the tank, so that the tank can be emptied by another pump, or the pump can be connected to an outside supply.

In spreading the oil goes from the pump back thru the tank and comes out thru the back head, down and to the left end of the distributing header across and up thru a spring-loaded relief valve, and back into the tank.

As the hot oil goes across the header it heats the upper end of the spray cocks, which is screwed into the header, and by convection heats the whole cock. The header swings around a packed joint at each end and can be raised and lowered.

The cocks are not operated by a fixed connection, but by pins in a bar which are placed about 3 inches apart, which allows each lever on a cock to be operated independently if desired, thus giving the operator, who stands on a step across the back at the level of the cocks, entire control over the width and position of the strip that is to be covered with oil.

In order to get a large spreading range without using excessive pressure, the cocks have two outlets with large and

G. M. C. 2-TON TRUCK AS OPERATED IN ROAD SPRINKLING, TREE SPRAYING AND FIRE FIGHTING. CAPACITY 3 BARRELS PER MINUTE.

Leaders in Municipal Work

United Trucks have set a pace in municipal work that is hard to follow. This is not due to chance or good luck but to the fact that they are constructed essentially for the *hard, rush* work encountered.

And during the summer months—when municipal work is at its height—the tremendous hauling capabilities of **United Trucks** become doubly valuable.

Their gigantic strength, tremendous power and rugged construction, combined with a minimum operating expense, are the factors that have made **United Trucks** the leaders in the field.

Hauling big loads of sand, gravel, coal, cement, paving material, brick, etc., is the kind of work they are built for. With our special dumping bodies and hydraulic hoists, the matter of unloading is but a matter of seconds.

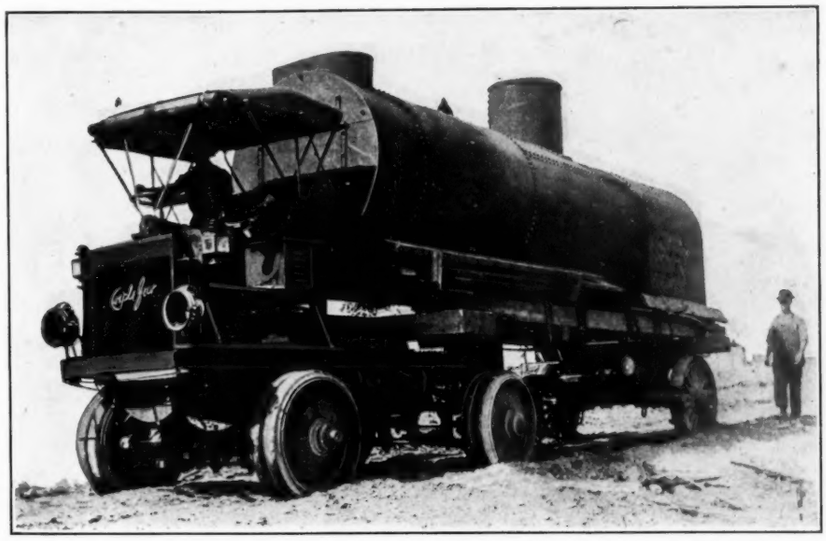
Made in 2, 3½, 4 and 5-ton sizes—all worm drive—all for heavy duty. Every mechanical feature well known by name and reputation.

For complete details and specifications, address

United Motors Company

690 North Street **GRAND RAPIDS, MICH.**

United Trucks



COUPLE-GEAR SIX-WHEELER AS OPERATED BY THE TENNESSEE NATURAL DEVELOPMENT CO., GREENVILLE, TENN. HAULING 100 H. P. BOILER INTO INTERIOR OF MOUNTAINOUS DISTRICT.

small nozzles and a 30-degree movement of the handle to the right or left opens either one.

In cases there are places where it is impracticable to get the truck, a ¾-inch metallic hose is attached to the header and the oil distributed by hand. The tank itself is covered with asbestos and a sheet steel jacket placed around the asbestos. Large tool boxes and running boards are put on so that equipment can be carried to tackle any kind of a job.

At the back of the tank there is a gage with a hand that makes one revolution from tank full to tank empty, so that the operator knows how much oil he has left at any time.

Los Angeles Road Maintenance Equipment.

The maintenance of the paved road system of Los Angeles County, California, is handled by seven 4-ton motor trucks and crews, the average crew consisting of foreman, driver and eight laborers. As the county is divided into four road districts with a district engineer in charge of each, it was found advisable to put the trucks and crews under the direct supervision of the district engineers.

In the first road district there are two trucks in use. A one-ton truck is also used at times for emergency patching jobs. This district includes about 125 miles of paved roads. In one of the small towns in the center of the district a warehouse is maintained which is used as headquarters for the trucks. In the fourth road district there are four trucks in service. Two of these operate from a warehouse located in the central part of the district and two from the central warehouse in the city of Los Angeles. There are about 185 miles of paved roads in this district. One motor patrol truck handles all the work in the third and fifth districts which includes about 100 miles of paved roads.

At the central warehouse in Los Angeles an oil pit and heating plant is maintained to supply oil to the two district warehouses and to the trucks operating from the central warehouse. Oil is transported in tank trucks and placed in 5-gallon buckets for storage at the district warehouses. At convenient places along the highways piles of rock and screenings are located for use of the motor-truck crews. Stone for the stock piles is shipped via rail to the nearest siding and hauled in wagons to the piles.

FULL EQUIPMENT FOR ROAD WORK.

Each patrol truck is equipped with a portable road-oil heater and distributer and an oil-bucket heater. (Described in the November, 1916, issue of MUNICIPAL ENGINEERING.) One wheelbarrow, shovels, picks, street brooms and lanterns are also part of the equipment. The amount of oil carried de-

A JEFFERY QUAD WITH A "SNOW SCOOT" CLEARING AWAY A WEEK-OLD SNOW.

Kissel *Built-in* Quality insures
continuous performance for contractors

Dependability is what contractors must have in the trucks they employ—and truck dependability depends on frame, axles, springs, brakes, motor and other structural parts.

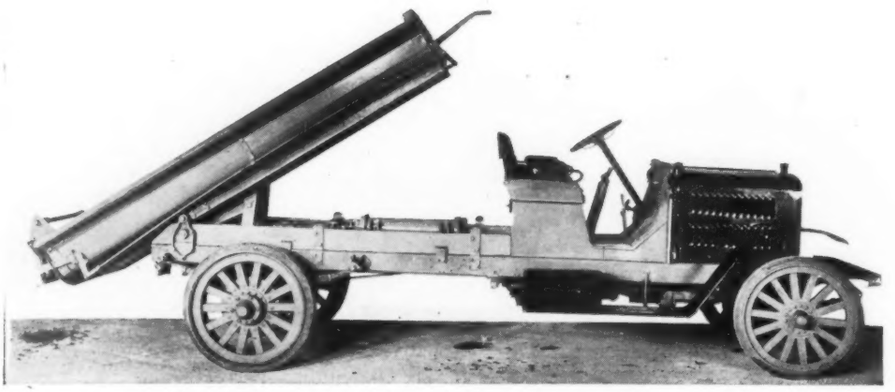
In KISSELKAR Trucks contractors find that the Kissel ***built-in*** quality gives an unusual durability seldom found in trucks.

The Kissel-built motor is power insurance for every grade. The perfected worm-drive rear axle is traction insurance on every kind of road. The Kissel superior-built axles are acknowledged 100 per cent efficient, while the Kissel mechanical superiorities and features are insurance of dependability under all wearing conditions.

More KISSELKAR Truck chasses are being used by contractors than ever before. Let us send you data and information on how they are making good for other contractors in all parts of the country.

Five different sizes to choose from. Chasses prices $1085 to $3750.

Kissel Motor Car Company
Hartford, Wis., U.S.A.



FEDERAL TRUCK, WITH 3-YD. LOAD OF GRAVEL, AFTER 8-FT. DROP THRU BRIDGE. NO INJURIES EXCEPT A BROKEN TAIL LIGHT. IN SERVICE OF ARTHUR O'KEEFE (CONTRACTOR), PLYMOUTH, IND.

pends on the character of the work to be performed. The amount varies from 60 to 150 five-gallon buckets.

The work handled by the patrol crews consists of: Sealing road surface, constructing shoulders, patching holes or places which have settled, cleaning gutters and shoulders, cutting down high places in the road surface and at times reconstructing wornout sections of the pavement. In all kinds of work where hauling is necessary the truck is used. Usually a patrol crew goes straight thru from one end of a road to the other. In this way it is often possible to keep a small tandem roller on the job. By using the roller a much better class of work is turned out than could be with hand tamping. The oil heater and unused buckets of oil can also be left along the roadside overnight, thus saving considerable time.

AVERAGE COST OF WORK IS LOW.

The average cost per month of operating a truck and crew is as follows:

Labor	$500
Foreman	100
Driver	90
Rock	150
Oil	150
Supplies for truck	30

There are often other items, such as roller, hauling rocks to stock piles, hauling oil, etc.

SPECIAL EQUIPMENT FOR EMERGENCY DEVICE.

The patrol crews have proven exceedingly valuable during stormy weather in protecting bridges and pavements from flood water. The character of the rivers in Southern California is such that they are liable to frequent change in course. The banks are low and subject to overflow. On account of the frequent changes in course many pile trestles have been erected in the past, both by the railroads and the county. During high water periods brush and driftwood lodge against the pile bridges. In this way the bridges are soon turned into dams, water is backed onto adjacent property and often the bridges give way, resulting in great damage caused by the sudden discharge of the accumulated water.

In order to guard against this trouble it has been the practice to assign truck crews to duty at the various threatened bridges. For this work a special equipment is necessary .

The equipment carried for flood-protection work consists of two or three hundred empty sacks, steel blocks and tackle, pike poles, lanterns, axes, saws, shovels, picks, etc. Some of the trucks have been equipped with a small boom derrick which is mounted in the center of the truck bed. This der-

SIGNAL VACUUM STREET CLEANER AS OPERATED BY THE CITY OF LOS ANGELES, CAL.

ACME
THE TRUCK OF PROVED UNITS

THE TRUCK THAT PAYS BIGGEST DIVIDENDS

The truck that stands up—the truck that's "on the job" every day—the truck you can depend upon—is the motor truck that pays the biggest dividends.

And Such a Truck is the ACME!

Acme proved units—Continental motor, Timken axles, Timken bearings and worm drive, Detroit springs, etc., plus in-built reliability of **Acme** construction, are positive assurance of dependable service.

The **Acme** truck represents the combined engineering skill and wisdom of the acknowledged leaders of the motor truck field.

It is built to meet the tough requirements of contracting and municipal haulage.

Write for our New Truck Book—It's Free!

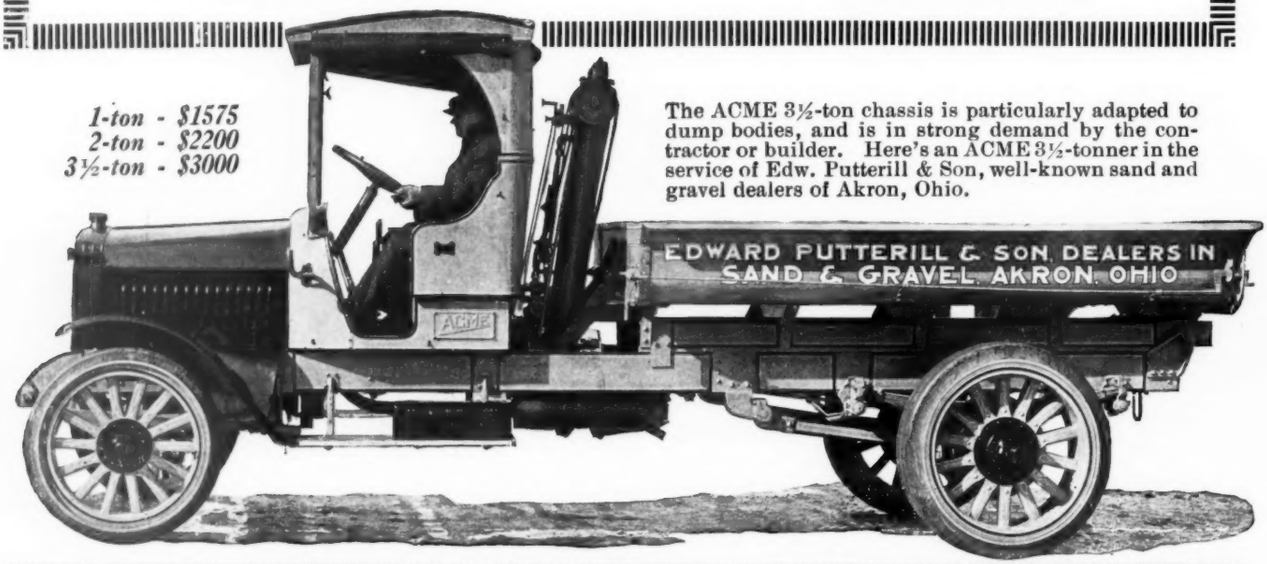
Our valuable new book—*"A Pointer to Profits"*—contains vital facts for the truck user or prospective buyer. Write today for your copy. Read the experience record of hundreds—many in your own business. Know how and why the **Acme** cuts delivery costs 30 to 50 per cent as compared to old methods. Write today, using space below for your request.

Cadillac Auto Truck Co.

144 Mitchell Street **CADILLAC, MICH.**

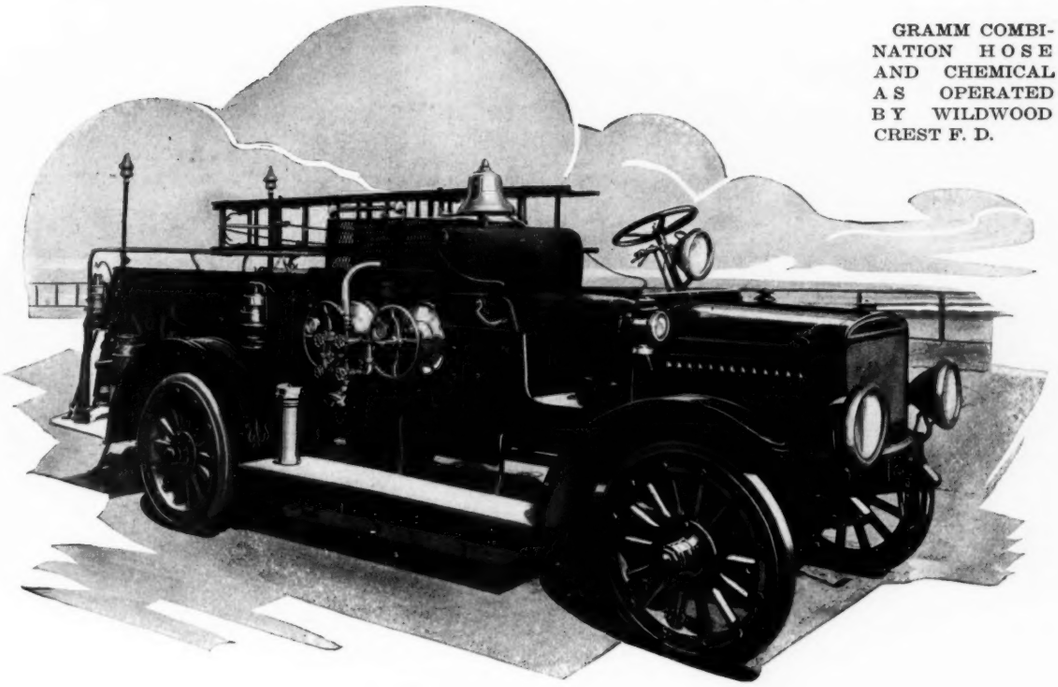
1-ton - $1575
2-ton - $2200
3½-ton - $3000

The ACME 3½-ton chassis is particularly adapted to dump bodies, and is in strong demand by the contractor or builder. Here's an ACME 3½-tonner in the service of Edw. Putterill & Son, well-known sand and gravel dealers of Akron, Ohio.



Write Your Reply Here—Tear Off and Mail Today

CADILLAC AUTO TRUCK CO.
144 Mitchell Street, Cadillac, Mich.



GRAMM COMBINATION HOSE AND CHEMICAL AS OPERATED BY WILDWOOD CREST F. D.

rick when used for lifting driftwood away from a bridge has proved very satisfactory. During rainy weather all trucks are equipped with canvas coverings over pipe frames.

Cuts Oiling Costs In Two.

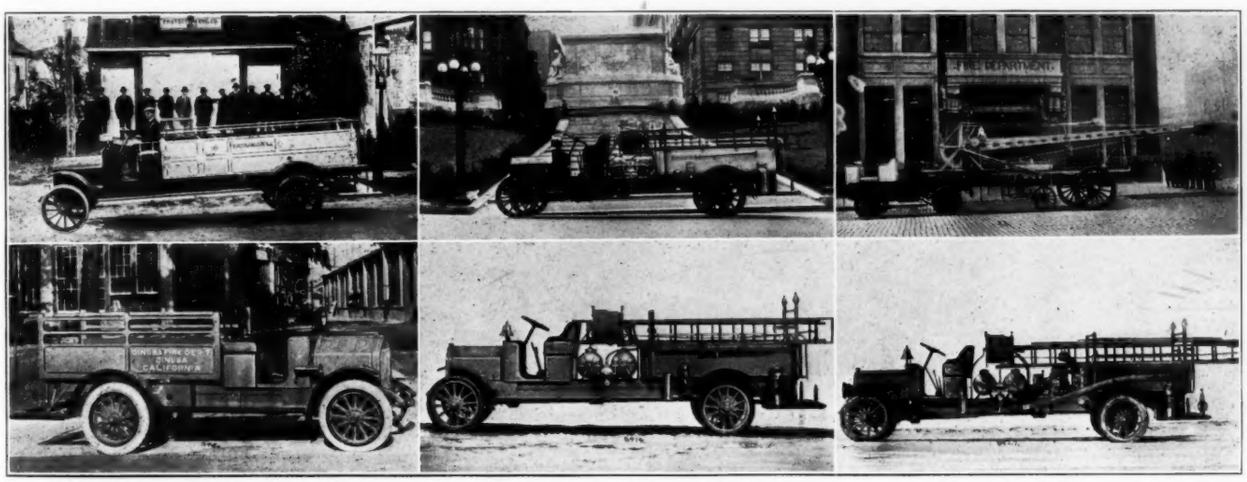
A 2-ton Jeffrey Quad purchased last summer by the Kenosha, Wis., County Board has made a very considerable reduction possible in the road work of that county. This truck was originally purchased with the idea of trailing a 600-gallon road oiler, hauling stone, gravel and the like for the construction and maintenance of Kenosha County roads.

"Maintenance on this truck," said Russel H. Jones, County Clerk of that county, "has been practically nothing. In fact, the entire expense for the past season's driving, outside of gasoline, oil, driver's wages and the like, have been less than $10.00.

"We normally haul a 2-ton load on the truck itself, with a trailer load of from 2 to 3½ tons, depending on the condition of the roads. By putting in a very slight amount of overtime now and then, we have been able to haul as much road material in a day as could be hauled with 4 teams in the same day.

"We average about 52 miles per day, trailing either the road-oiler or the dump-wagon as above mentioned, consuming not to exceed 15 gallons of gasoline per day so that our gasoline consumption, even with the use of the trailer, is on the basis of approximately 4 miles per gallon."

Prior to using the Quad for this particular work, it required four horses to handle this road-oiler on the same job and at the end of one round trip of 14 miles these horses had to be replaced with fresh horses, particularly in the hot



GARFORD HOSE AND SQUAD TRUCK AS OPERATED BY THE CITY OF PORT WASHINGTON, L. I., N. Y.

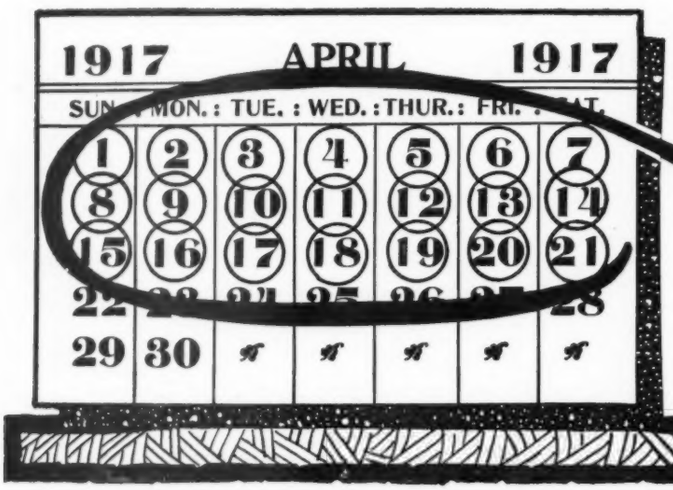
GARFORD HOSE AND SQUAD WAGON AS OPERATED BY THE CITY OF DINUBA, CAL.

GARFORD TRIPLE COMBINATION AS OPERATED BY THE CITY OF ROSLYN, L. I., N. Y.

GARFORD COMBINATION CHEMICAL AS OPERATED BY TWO WESTERN OHIO MUNICIPALITIES.

GARFORD AERIAL TRUCK AS OPERATED BY SEVERAL NEW YORK MUNICIPALITIES.

GARFORD TRIPLE COMBINATION AS OPERATED BY THREE PENNSYLVANIA MUNICIPALITIES.



3 WEEKS
Steady Grind
20 *hours*
out of every 24

Stegeman
SIX CYLINDER
TRUCKS

"*Some Pace!* But my **Stegeman** hung on without missing a shot! *Overloaded*, too; almost every trip. And *not a penny* paid out for repairs." That's what John Peters, Waterford, Wis., says of his **Stegeman** Truck.

Characteristic **Stegeman** performance! The six-cylinder steady pull *conquers* long hours of continuous, hard work just as it does rough roads and hindering hills.

At all speeds! All times! The **Stegeman** pull is a smooth *even* power flow! Every **Stegeman** governor is set so that the *big pull* comes before limit speed is reached.

That avoids the clattering rack of the *over-speeded engine* that follows when a governor is taken off to make the truck *deliver!* Adds years to **Stegeman** life.

Every **Stegeman** a self-starter—and the *only self starting truck* on the market. This feature alone saves as high as 40 per cent on engine wear! Cuts down waste of gas that accompanies the idled engine.

Standard! Every unit in the **Stegeman** is approved. Their combination make a truck fitted especially for *severe service;* not made for easy selling. Compare **Stegeman** specifications with *any other!* They're the *basis* of **Stegeman** superiority.

Stegeman Motor Car Company

MILWAUKEE
WISCONSIN

weather. The Quad handles this same work with remarkable ease, having repeatedly made 4 round trips per day even in the extreme heat of the summer, and with one or two exceptions on extremely hot days, even the motor has not heated up beyond a point of maximum efficiency.

Distributes Cold Oils at Low Cost.

An efficient type of road oiler is in use by the Daniels Road Oiling Co., of Providence, R. I. The outfit, which is illustrated in this issue, consists of an Autocar on which is mounted a 550-gallon tank, with a Goulds rotary pump. This pump is driven by the truck engine. The pipes and sprayers used will handle any cold road oil that is 45 per cent asphalt or less.

In practice the oil is usually applied to city streets in so small a quantity that closing the street or covering the oiled surface with sand are both unnecessary. The range of the machine is from 4 yards to 30 yards per gallon, 8 yards being usually approximated. Four to six treatments are given in a season.

The truck illustrated had an output that ran on many days as high as 3,300 gallons. Costs per gallon, considering only gasoline and lubricating oil, were as follows:

Gas at 23c	.00105
Oil and grease	.00008
	.00113

Daily average output of oil, 2,422 gallons. With a 3½-ton truck operated in the same service this truck carrying a 940-gallon tank costs were as follows:

Gas at 23c	.00112
Oil and grease	.00028
	.00140

Daily average output, 2,138 gallons.

More Work at Less Cost.

The economy of a good motor truck in the work of a street department has been demonstrated by the record of a 2-ton Armleder in the employ of the city of Franklin, Pa.

This truck went into service July 3, 1916, and worked steadily every day after its initial installation. Aside from the time for inspection and the time consumed in making minor adjustments, it has been shown conclusively that loss of time with this truck is a negligible quantity, especially when compared to the inability to use their horses at all times and under identical conditions.

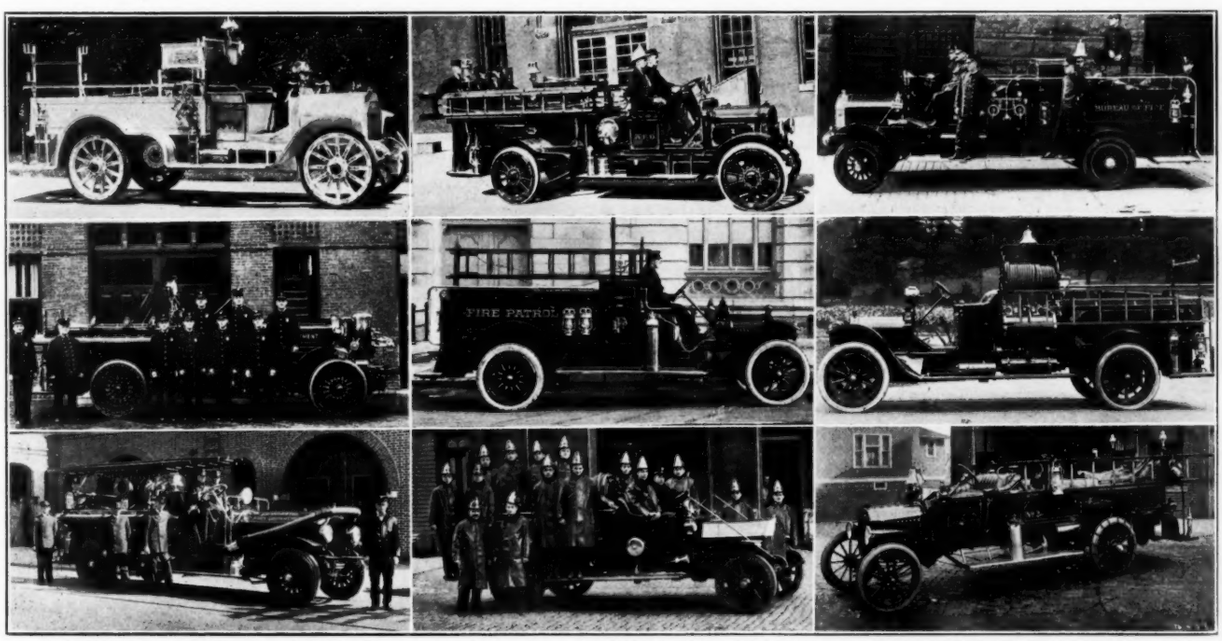
The truck worked at hauling a street sweeper and at gathering up sweepings. It also hauled a scraper in grading dirt streets. The work required much running in low gear and a great many stops with the engine running.

But in spite of these conditions, tending to increase the consumption of gasoline, the cost of operation for 3,296 miles figured out at 9 cents a mile. Truck costs amounted to $265, and depreciation and interest of $200 were added, making total truck expense $465. With this expenditure the truck did a great deal more work than had been accomplished by two teams the previous year at an expense of $614.92.

St. Louis Oils at Less than Sprinkling Cost.

The economy effected by a motor truck equipped with a road-oiling apparatus in the service of the city of St. Louis, Mo., during the year of 1915, resulted in the purchase of a second similar truck by that municipality. J. L. Laxton, engineer in charge of bituminous roads and streets in the department of streets and sewers, reports that the first White combination truck applied 130,000 gallons of oil at one-seventh of the cost of using horses and wagons, without considering the limitations and inferior work of the latter equipment.

The amount regularly paid for team hire was $4.40 per



FEDERAL COMBINATION HOSE, CHEMICAL AND SQUAD WAGON, CITY OF LITTLETON, COL.

AHRENS-FOX PUMPER, MILWAUKEE, WIS., EQUIPPED WITH SEWELL CUSHION WHEELS.

SEAGRAVE TRIPLE-COMBINATION CENTRIFUGAL PUMPER, CITY OF CHARLESTON, S. C., EQUIPPED WITH SEWELL CUSHION WHEELS.

G. M. C. COMBINATION HOSE, CHEMICAL AND LADDER TRUCK, CITY OF ALMEDA, CAL.

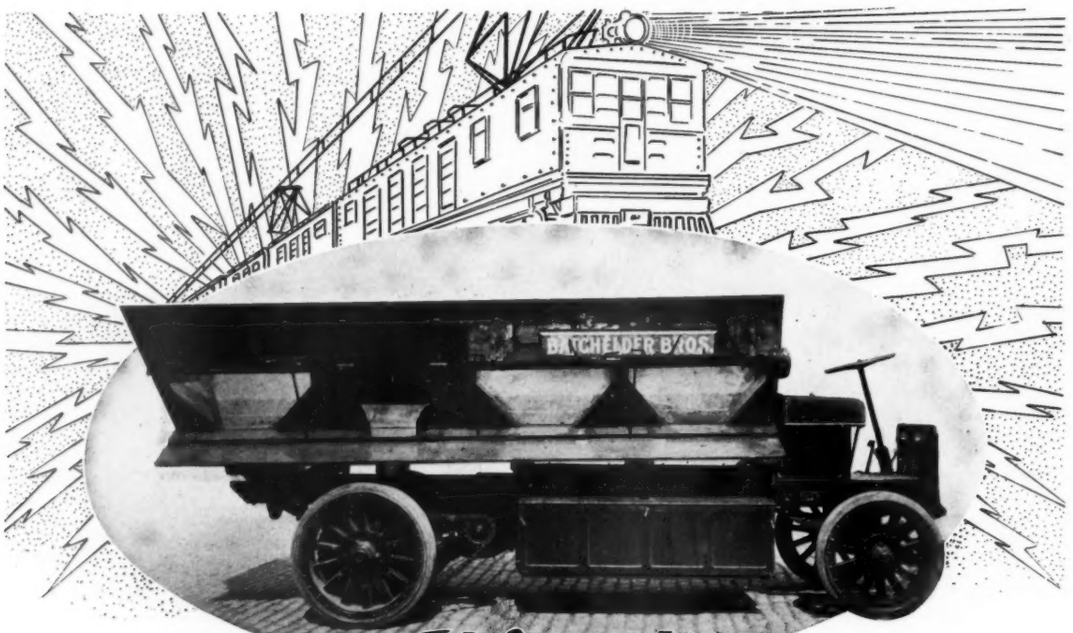
WHITE FIRE PATROL, CITY OF NEW YORK, N. Y.

STEGEMAN COMBINATION HOSE, CHEMICAL AND LADDER TRUCK, CITY OF MILWAUKEE, WIS.

MACK COMBINATION HOSE AND CHEMICAL, CITY OF PHILADELPHIA, PA., EQUIPPED WITH SEWELL CUSHION WHEELS.

WHITE COMBINATION CHEMICAL AND HOSE TRUCK, CITY OF CHICO, CAL.

SMITH FORM-A-TRUK COMBINATION CHEMICAL AND HOSE TRUCK, FORD CHASSIS, CITY OF ELKHART, IND.



Atlantic

The Long Distance Electric

Up the Long Slope of the Continental Divide Electricity swiftly pulls heaviest trains. *All-weather* traction reliability! Thus *Electricity* conquers the long, heavy haul!

Mammoth electric locomotives and the sturdy **Atlantic** both have the ***same vital force*** behind their steady pull. Both fit conditions with mechanical ***perfection.***

Every **Atlantic** has a ***"more than big-enough"*** battery, chosen to deliver ***excess*** pull. **Atlantic** power supply holds force in ***reserve*** to climb, overloaded, straight up the generally avoided grade—to pull out of ***"bad road"*** mudholes.

Cables that carry power from battery to controller—from controller to motor—are all ***generously large.*** That cuts down resistance (electrical ***friction***) and insures efficient use of every kilowatt of power the battery provides.

Friction loss in wheels, transmission and motor is cut to the ***vanishing point.*** Power goes into the push that delivers the load, because there are no ***hard turning*** parts to consume and waste it.

Test tells—Best by Test!

Atlantic Electric Vehicle Co.

Plant: 893 Frelinghuysen Avenue
NEWARK, NEW JERSEY.

Send for the "Twenty Reasons Why" you should operate Atlantic Trucks.

day of 8 hours. Eighty-seven miles of soft-paved streets were oiled, using ¼ gallon of oil to the square yard. This was put down at a cost of ½ cent a yard. St. Louis has 540 miles of soft-paved streets, and the city plans eventually to oil all of these thorofares.

By applying the oil as early in the season as weather conditions will permit, repeating the operation a week or ten days later, and then making a third application about two weeks after the second, the surface becomes dustless and almost water-proof. The truck and two men are able to distribute from 3 to 6 tank loads in 8 hours, depending on the length of the haul from the loading station. With oil at 2½ cents per gallon, the cost of oiling soft-paved streets from curb to curb, 36 feet wide, amounted to $313 a mile.

SAVED $72 PER MILE.

Previous to the installation of the motor distributer the average cost of sprinkling streets was $385 per season-mile. Sprinkling was unsatisfactory because the streets soon became dusty and the water left no permanent result, whereas the distributer rendered the streets permanently dustless and tended largely to prevent the surface from wearing out under constant traffic. The truck therefore showed a saving of $72 per mile and gave a treatment that was immeasurably better.

Fayette County Spreads 80,000 Gallons of Liquid Asphalt.

Motor truck facilities and equipment developed especially for this work enabled Fayette county, Kentucky, to distribute 80,000 gallons of liquid asphalt in treating 25 miles of macadam road during the 1915 season.

The county's new highway supply station is designed with two 12,000-gallon storage tanks resting on concrete cradles, with a railroad siding above the tanks and a driveway for the distributer below them. When a carload of asphalt arrives it is spotted above the storage tanks and connected to a steam heating system. As soon as the asphalt is heated to a state of fluidity it is discharged by gravity into the storage tanks. These tanks have interior steam coils to maintain the asphalt in liquid form and facilitate its transfer to the combination truck.

Exploding the Short-Haul Fallacy.

In the early days of the motor truck the term "short-haul" was a bugbear to the business man who had not thoroly investigated the possibilities of the motor-driven commercial vehicle. Some one had told him the truck was all right for long-distance work, but that it was a liability where the distance the goods were to be transported was short. Now he is facing instances every day in which the short-haul fallacy is being exploded. He is learning that, given proper loading and unloading facilities in connection with volume of business, the truck is as profitable on ¼-mile as on 4 or 5-mile hauls.

C. R. Norton, truck sales manager of the Packard Motor Car Company, cites an instance of this in the record made by a 6-ton Packard coal truck in the service of the Jurgen-Rathjen Company, Long Island City. In one day recently, this truck, working from 8:30 a. m. till 4:30 p. m., and with an hour off at noon, hauled 180 tons of coal over a delivery route of ⅜ mile, the round trip being only ¾ mile. The total truck cost of this typical day's work, including interest on the investment, depreciation, insurance, fuel, lubricant, wages of driver and helpers and all other items, was only $15.35.

"The performance of the Rathjen truck was not extraordinary," Mr. Norton says. "Every day we hear of like records being made by Packard owners in a wide variety of lines. The short-haul scare of the timid business man who hesitates over the introduction of modern delivery equipment is a thing of the past."

TEN PACKARDS AT PLATTSBURG.

Ten Packard chainless motor trucks have been assisting Uncle Sam in the development of his citizen soldiery at the Plattsburg, N. Y., training camp. The trucks are of 1½ tons capacity, and are painted a neutral adobe-tan color. They have tarpaulin-covered army transport bodies and are exactly like the 122 Packards which are carrying supplies to General Pershing's army in Mexico. Eleven employes of the Packard Motor Car Company accompanied the trucks, having enlisted for service during the several months' duration of the Plattsburg camp. The men are all expert mechanics of long experience in the Packard shops and will act as instructors to those volunteers who desire to take special training in motor transport work.

The complete machine weighs 9,052 pounds.

Three wheels of a **DUPLEX** Truck sank almost to the hubs in a "soft" spot on a heavy grade.

Only one front wheel could get traction on firm ground. But the three **Duplex** wheels, embedded in mud, did not spin—because all the motive power was automatically thrown by the Duplex-Adler self-locking differentials to the front wheel having a "footing."

And the front wheel, alone, pulled the **Duplex** with its 3½-ton load out of the mud.

The Duplex-Adler self-locking differential is but one of the many exclusive mechanical features of the Original Four-Wheel Drive Truck described in our 1917 catalog. Write today for a copy.

Address all communications to Dept. 112

DUPLEX TRUCK COMPANY

LANSING, MICH.

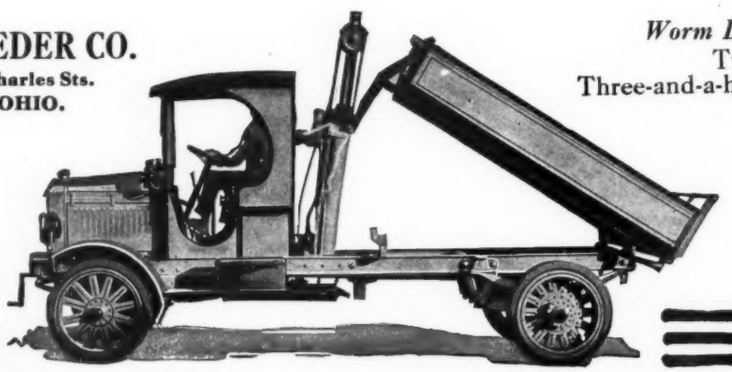
ARMLEDER
Motor Trucks

ARMLEDERS IMPROVE THE ANNUAL REPORT

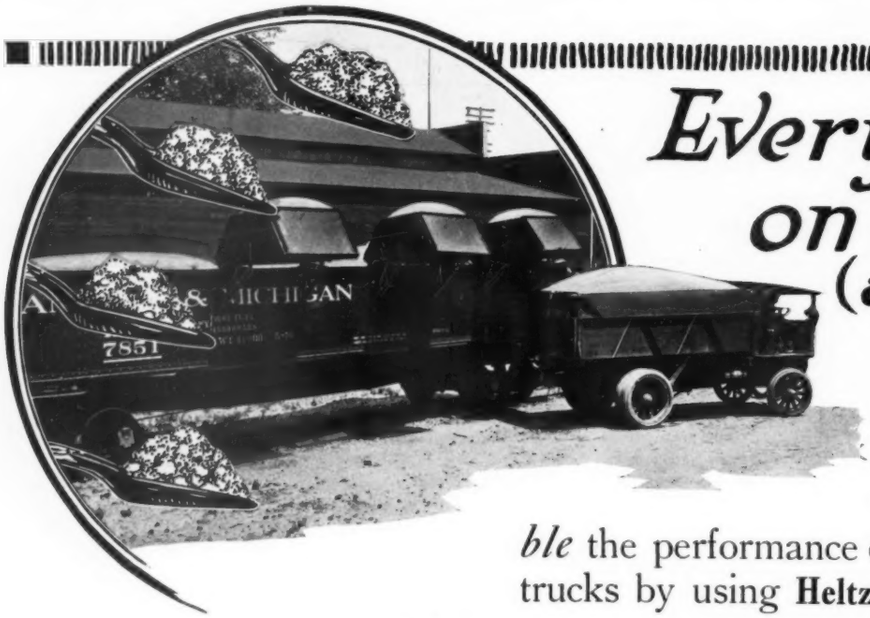
The city department that uses **Armleder** trucks in its construction work is proud to make its reports.
Reduced hauling costs, labor saved because material is always at hand promptly, contribute in an important way to the general showing of efficiency.
During the season when construction goes forward fastest, you can depend on an **Armleder** truck being on the job every day—and every day hauling a maximum tonnage for you.
Its right design, its incomparable materials—show in its steadiness and reliability of operation.

Write today for the facts.

THE O. ARMLEDER CO.
Twelfth, Plum & Charles Sts.
CINCINNATI, OHIO.



Worm Drive—
Two-ton
Three-and-a-half-ton



Every Shovel on the Move (all the time)

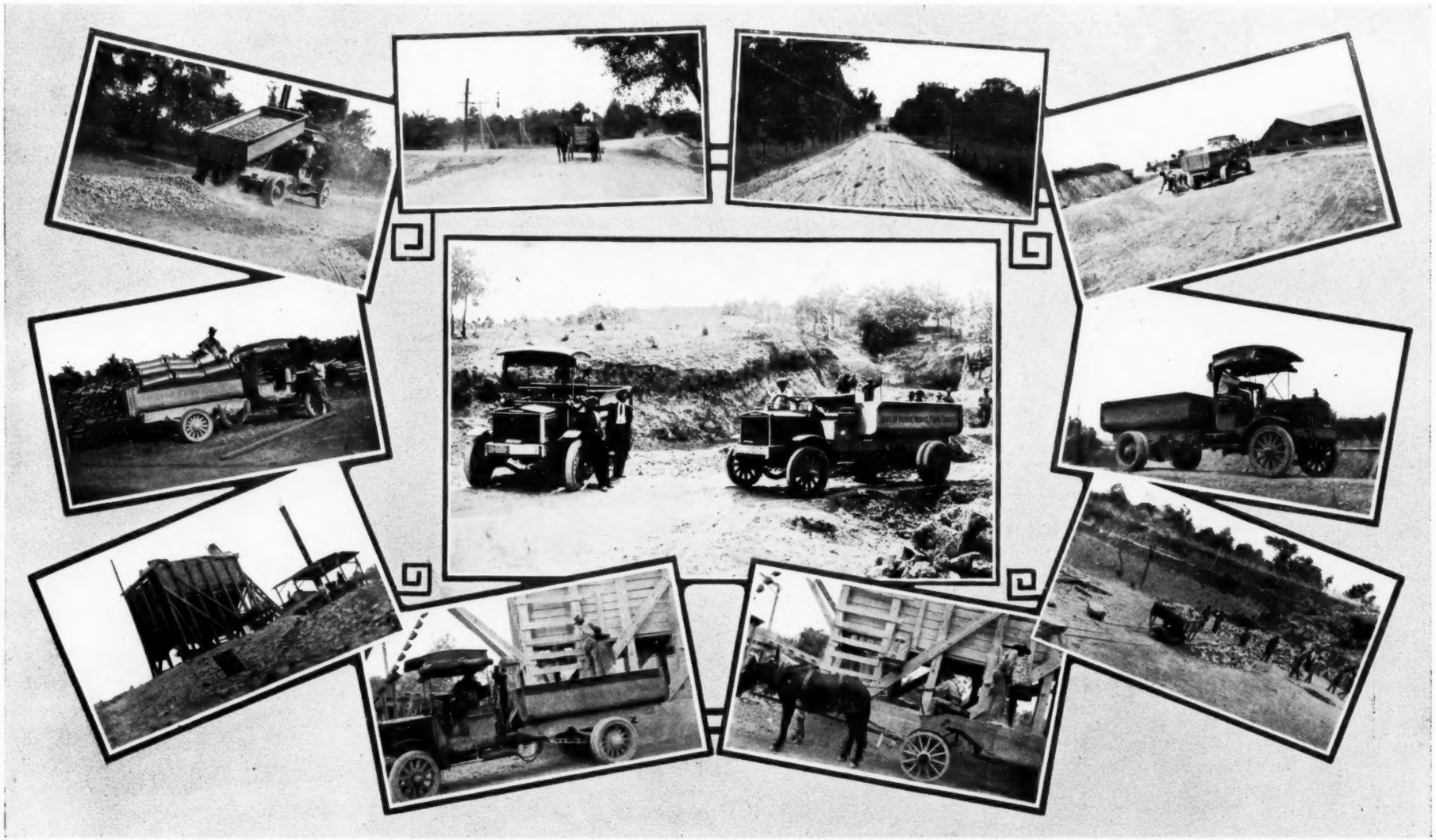
"That's the Reason," says Tilghman H. Moyer (Contractor), Allentown, Pa., "why we *double* the performance of shovelers, drivers and trucks by using **Heltzel Lightning Loader Skips.**

"Our two skips put the load on a 3-ton truck in *three minutes!* Save 9 to 10 minutes a load over the 'gondola to truck' method of shoveling. Keep men and drivers *on the move —speed up* the gangs in the street."

One of the many cases where **Heltzel Lightning Loader Skips** are more than paying for themselves by their dependable everyday *savings.* They'll do the same for you! Ask us *how!!*

The Heltzel Steel Form & Iron Co.

Youngstown Road **WARREN, OHIO**



FEDERAL TRUCKS BUILDING GEORGIA ROADS—"LEADI NG TO ROME."

T. E. GRAFTON, SUPERINTENDENT, DEPARTMENT OF PUBLIC WORKS (FLOYD COUNTY), ROME, GA., STATES THAT THE TWO FEDERAL 3½-TON TRUCKS ARE EACH DOING THE WORK OF FOURTEEN DOUBLE TEAMS AT A COST OF SLIGHTLY LESS THAN ONE-THIRD THE COST OF TEAM HAULING.

The South Bend "Double Duty" *Hoosier* Pumper solves the fire-fighting problem of the ***small city and town!*** Does it in a ***Big-City Way;*** at a price well within the reach of communities that need adequate fire protection.

The South Bend "Double Duty" *Hoosier* Pumper is also putting the Fight into the fire-fighting of our ***largest*** cities! Outlying districts, suburban tracts and factory sections need no longer rely on heavy down-town apparatus! Central station pumpers remain on duty in congested, down-town districts (where they belong).

The *Hoosier* Pump is *not* a makeshift contraption on a re-built pleasure-car or truck chassis! It is a piece of ***real*** motor fire apparatus especially built for fire fighting! It is new, original and different! The ***latest*** word in fire apparatus design and construction! It is not only a combination hose and chemical (carrying all necessary tools requisite to successful fire fighting) but it is a ***real*** pumper delivering a ***real*** fire stream!

The *Hoosier* Pumper is ***something new!***
Send for its autobiography!!

SOUTH BEND MOTOR CAR WORKS
SOUTH BEND, IND.

Eastern Representative:
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142 Market St.
NEWARK, NEW JERSEY